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NATIONAL DAM SAFETY PROGRAM. PURINA LAKE DAM (MO 31497), MISSOU--ETC(U)
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This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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PURINA LAKE DAM
FRANKLIN COUNTY MISSOURI
MISSOURI IDENTIFICATION NO. MO 31497

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

OCTOBER, 1980

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Purina Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Purina Lake Dam (MO 31497).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria.

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — 5 JUN 1981
Chief, Engineering Division — Date

APPROVED BY: SIGNED — 8 JUN 1981
Colonel, CE, District Engineer — Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Purina Lake Dam
State Located	Missouri
County Located	Franklin County
Stream	Tributary to Labadie Creek
Date of Inspection	October 7, 1980

Purina Lake Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general conditions of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers.

Purina Lake Dam has a height of about thirty-eight (38) feet and a storage capacity at the minimum top elevation of the dam of seventy (70) acre-feet. In accordance with the guidelines, a small size dam has a height greater than or equal to twenty-five (25) feet but less than forty (40) feet and a storage capacity greater than or equal to fifty (50) acre-feet but less than one thousand (1,000) acre-feet. The size classification is determined by either the storage capacity or height, whichever gives the larger size category. Purina Lake Dam is classified as a small size dam.

In accordance with the guidelines and based on visual observation, the dam is classified as having a high hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately three (3) miles downstream of the dam. Within the damage zone are Highway MM, three or more dwellings, three stores, a service station and a fire station.

The inspection and evaluation indicates that the spillways do not meet criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the small volume of water impounded and the downstream channel from the dam, one half of the Probable Maximum Flood is the appropriate spillway design flood. The spillways will pass the 100-year flood (1% probability flood - a flood having a one percent chance of being exceeded in any one year) without overtopping the dam. The spillways will pass 24% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

The upstream slope, crest and spillways of this dam are in very good condition and are very well maintained. The downstream slope has had very little, if any, maintenance and is in poor condition due to dense tree and brush growth. Rodent holes were also observed on the downstream slope.

Design data were not available for this dam. Based on the observations made during the field inspection of the dam, the following remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams:

a. Alternatives.

(1) The height of the dam and/or the size of the spillways should be increased to prevent overtopping by 50 percent of the Probable Maximum Flood. In either case, the spillways should be protected to prevent erosion.

b. Operation and Maintenance Procedures.

(1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams. These analyses should include the appropriate seismic Zone 2 earthquake loadings.

(2) Trees and brush should be removed from the downstream slope. Tree removal should be done under the guidance of an engineer experienced in the design and construction of dams.

(3) The downstream slope should be inspected and reevaluated after removal of the trees and brush.

(4) Rodent holes on the downstream slope should be repaired.

(5) The amount and nature (color, sediment, etc.) of the seepage effluent should be monitored on a regular basis, particularly under maximum reservoir levels.

(6) A program of regular inspection and maintenance should be initiated with inspection reports made a part of this project file. Inspection and maintenance operations should include observations on seepage, prevention of tree growth and curtailment of rodent activity.

Rey S. Decker
E-3703

Gordon Jamison

Garold Ulmer
E-19246

Harold P. Hoskins, Chairman of the Board
Hoskins-Western-Sonderegger, Inc.
E-8696

FORM 1

BINDING EDGE

PHOTO NO. 1 - OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
PURINA LAKE DAM - MO 31497
FRANKLIN COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Purina Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams", dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Embankment. The embankment is an earthfill structure approximately 650 feet in length and 38 feet in height with a maximum storage capacity of approximately 70 acre-feet at minimum top of dam elevation.

(2) Principal Spillway. The principal spillway is uncontrolled and consists of twin 18-inch diameter corrugated metal pipe culverts with a concrete headwall on the inlet end. The culverts are located approximately 50 feet east of the north abutment of the dam and are cut into and through the ridge line that defines the boundary of the drainage area of the dam.

(3) Emergency Spillway. The emergency spillway is an uncontrolled asphalt surfaced road constructed over the twin 18-inch diameter corrugated metal pipe principal spillway. The road is constructed on the ridge line that defines the boundary of the drainage area of the dam as shown in Photo No. 1 and on Plate A-1.

(4) Low-Level Outlet. There is no low level outlet.

(5) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located approximately one and one-quarter miles northwest of Gray Summit in the northeast corner of Franklin County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the NE ¼ of Section 6, T43N, R2E.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Purina Lake Dam has a height of 38 feet and a storage capacity of 70 acre-feet. This dam is classified as a small size dam. A small size dam has a height greater than or equal to 25 feet but less than 40 feet and a storage capacity greater than or equal to 50 acre-feet but less than 1,000 acre-feet. The size classification is determined by either the storage or height, whichever gives the larger size category.

d. Hazard Classification. Guidelines for determining hazard classification of dams and impoundments are presented in the guidelines as referenced in paragraph 1.1c above.

Aerial photographs of the downstream damage zone of this dam were taken in October, 1980. These photographs were used as reference in the field observations of the damage zone which were made during the inspection. Based on the field observations and on the referenced guidelines this dam is in the High Hazard Potential Classification. The estimated damage zone extends approximately three miles downstream of the dam. Within the damage zone are Highway MM, three or more dwellings, three stores, a service station and a fire station.

e. Ownership. The dam is owned by the Ralston-Purina Research Corporation, Route 2, Box 423, Gray Summit, Missouri 63039 Attention: Mr. Don Brown, Farm Manager.

f. Purpose of Dam. The dam impounds a recreational lake covering about 5.6 acres and containing about 54 acre-feet of water at normal pool.

g. Design and Construction History. Mr. Brown stated that an abandoned railroad fill at the site was converted to a dam in 1957. The culvert through the fill was evidently removed (no evidence of culvert observed during the inspection), and the excavation was backfilled. The crest was widened approximately 10 feet, and a new upstream slope was constructed at a flatter slope than the slope of the original railroad embankment. The spillways were also constructed at this time. No work was done on the downstream slope.

h. Normal Operating Procedure. There are no operating facilities for this dam. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillways.

1.3 PERTINENT DATA

a. Drainage Area. 44 acres (0.069 square miles).

b. Discharge at Damsite.

(1) All discharges at the damsite are through an uncontrolled principal spillway (twin 18-inch corrugated metal pipe culverts with a concrete headwall) and an uncontrolled emergency spillway (low road section constructed over the 18-inch corrugated metal pipe culverts).

(2) Estimated maximum flood at damsite -- unknown.

(3) The principal spillway capacity varies from 0 c.f.s. at elevation 571.0 feet to 19 c.f.s. at the crest of the emergency spillway (elevation 573.2 feet) to 21 c.f.s. at the minimum top of dam (elevation 573.7 feet).

(4) The emergency spillway capacity varies from 0 c.f.s. at its crest (elevation 573.2 feet) to 34 c.f.s. at the minimum top of dam (elevation 573.7 feet).

(5) Total spillway capacity at the minimum top of dam is 55 c.f.s. ±.

c. Elevations (feet above M.S.L.).

(1) Observed pool - 567.0±

(2) Normal pool - 571.0±

(3) Spillway crests

Principal - 571.0±

Emergency - 573.2±

(4) Maximum experienced pool - unknown

(5) Top of dam (minimum) - 573.7

(6) Streambed - 536±

(7) Maximum Tailwater - unknown

d. Reservoir. Length (feet) of pool

(1) At principal spillway crest - 750±

(2) At emergency spillway crest - 820±

(3) At top of dam (minimum) - 850±

e. Storage (Acre-feet).

(1) Observed pool - 35±

(2) Normal pool - 54±

(3) Spillway crests

Principal - 54±

Emergency - 66±

(4) Maximum experienced pool - unknown

(5) Top of dam (minimum) - 70±

f. Reservoir Surface (Acres).

(1) Observed pool - 4.6±

(2) Normal pool - 5.6±

(3) Spillway crests

Principal - 5.6±

Emergency - 6.2±

(4) Maximum experienced pool - unknown

(5) Top of dam (minimum) - 6.3±

g. Dam.

(1) Type - Earth fill

(2) Length - 650 Feet ±

(3) Height - 38 Feet ±

(4) Top Width - 23 Feet ±

(5) Side slopes.

(a) Downstream - 1V on 1.5H (measured)

(b) Upstream - 1V on 2.3H (measured on exposed slope)

(6) Zoning - unknown

(7) Impervious core - unknown

(8) Cutoff - unknown

(9) Grout curtain - unknown

(10) Wave protection - Riprap

(11) Drains - None

h. Diversion Channel and Regulating Tunnel. None.

i. Spillways.

(1) Principal

(a) Type - Uncontrolled, twin 18-inch diameter corrugated metal pipe culverts with a concrete headwall.

(b) Crest (invert) elevation - 571.0 (left and right culvert)

Outlet (invert) elevation - 570.0 (left and right culvert)

(c) Length - 38 feet (left and right culvert)

(2) Emergency

(a) Type - An uncontrolled asphalt surface road constructed over the twin culvert principal spillway.

(b) Control Section - The 23-foot width asphalt surfaced road acts as a broad crested weir. The centerline profile of the road is parabolic in shape with the low point being located approximately 25 feet east of the twin culvert principal spillway. The approach to the upstream edge of the asphalt as well as the runoff section downstream from the asphalt slopes at approximately 1V on 6H.

(c) Crest elevation - 573.2 (minimum)

(d) Upstream Channel - Open and stable with a 12.5% grade from the headwall to the waterline.

(e) Downstream Channel - Open and well vegetated with a 6.9% grade for approximately 100 feet. It then drains into a heavily wooded channel which exits into another small creek approximately 500 feet north of the spillways.

j. Regulating Outlets. None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were available for this dam.

2.2 CONSTRUCTION

No construction data were available. It was reported by Mr. Don Brown that the original embankment was an old railroad fill. In 1957, the culvert through the fill was removed, a new upstream section was added to the railroad fill and the spillways were constructed.

2.3 OPERATION

No data were available on spillway operation. Mr. Brown reported that the principal spillway has operated at maximum capacity.

2.4 EVALUATION

a. Availability. No data were available.

b. Adequacy. The field surveys and visual observation presented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Purina Lake Dam was made on October 7, 1980. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska, making the inspection were:

Rey S. Decker - Geotechnical
Garold G. Ulmer - Hydraulics and Hydrology
Gordon Jamison - Hydraulics and Hydrology

The representative of the owner, Mr. Don Brown, was not present during the inspection, but was interviewed by telephone.

b. Dam.

(1) Geology and Soils (abutment and embankment). This upland embankment consists of and rests on the silts and clayey silts of the Menfro soil and underlying loess. Ten to twenty feetof loess mantle the Cotter formation; a light gray to light brown, medium to finely crystalline, cherty dolomite. The significant structural features within a 10 mile radial distance are the Moselle Fault and the Eureka-House Springs anticline.

Groundwater movement at the dam is controlled by the loess and Menfro soil. Seepage from the impoundment and local precipitation infiltrates to the relatively tight Cotter formation on which it perches and moves down valley. Local potentiometric surfaces of groundwater in the Jefferson City Formation and Roubideaux formation are at 130 ft depth indicative of the confinement beneath the Cotter formation aquiclude.

The Moselle Fault (Frank, 1945) located approximately 9 miles west of the site is the site of a deep-seated earthquake in May 1945. The embankment occurs in Seismic Zone 2 with a moderate probability of earthquake damage. Earthquakes with a Modified Mercalli intensity at or greater than IV within 50 radial miles are as follows: 1902 (VI), 1911 (IV), 1930 (IV), 1933 (IV), and 1945 (IV).

The Eureka-House Springs anticline crests approximately 10 miles to the east.

Bedrock porosity is low with a low potential for sinkhole collapse in the upper portion of the Cotter formation.

Samples of the embankment materials taken by hand auger were field classified as clay silts and silty clays (ML and CL).

The embankment materials were borrowed from the loess mantle of the surrounding ridges. Materials in the valley section are CL-ML alluvium derived from the loess covered slopes. No bedrock formations were observed at the site.

(2) Upstream Slope. The upstream slope is well covered with durable limestone riprap to within about 2 feet of the crest. The riprap has a maximum size of about 8 inches and nominal size of about 1 inch. No erosion was observed on the slope. No slumps, cracks, rodent activity or tree growth was observed. Photos 3 and 14 show the upstream slope. The reservoir elevation appeared to be 2 to 3 feet below normal pool level.

(3) Crest. The crest of the dam serves as a roadway and is paved with asphalt. The profile of the crest is quite uniform at about elevation 574 except for a section about 80 feet long on the right end which serves as the emergency spillway. No cracks, deformations, trees or rodent activity were observed on the crest. Photo 2 shows the crest. There was no evidence to indicate that the dam has ever been overtopped.

(4) Downstream Slope. The downstream slope consists of the old railroad fill. It is quite steep (1V on 1.5H) and almost completely covered with brush and trees up to 15 inches in diameter. The dense vegetative cover made it almost impossible to observe surface conditions on the slope (slumps, slides, etc.); however, surface erosion of the slope did not appear to be excessive. Photos 4, 5 and 6 show the downstream slope. A few rodent holes, up to 15 inches in diameter, were observed on the lower part of the slope (5 to 10 feet up from the toe). Photo 9 shows a rodent hole. No seepage was observed along the toe of the embankment. However, seepage was out cropping in the bottom and banks of the old channel which flows approximately parallel with the toe of the dam between stations 2+50 and 4+50. Total seepage discharge in the old stream channel was estimated at 1 to 2 gpm. All seepage was clear and no piping or boils were observed. Photos 7 and 8 show the seepage in the old channel. Borings on the slope indicated CL-ML materials to a depth of 2 feet.

c. Appurtenant Structures.

(1) Principal Spillway. The principal spillway, located in the right abutment, consists of two 18-inch corrugated metal pipe culverts with a concrete headwall. The headwall and pipes appeared to be in good condition. There was no evidence of any recent flows through the spillway. No erosion was observed at the outlet of the spillway. Photos 10 and 11 show the principal spillway.

(2) Emergency Spillway. The asphalt surfaced road is in good condition with no visible signs of distress. The approach area from the reservoir is open with no obstructions and is well vegetated. The runoff section from the downstream edge of the asphalt is well vegetated. There was no evidence of recent flow through the spillway, and there was no evidence of erosion in the spillway exit channel. Photo 10 shows the roadway over the culverts.

(3) Low-Level Outlet. There is no low level outlet for this structure.

d. Reservoir Area. The area bordering the reservoir is well vegetated with grass, and no significant erosion was observed around the reservoir. Photos 1 and 15 show the reservoir. The nonvegetated (bare) strip around the perimeter of the reservoir reflects the abnormally low pool level. There was no evidence of heavy siltation.

e. Downstream Channel. The channel downstream from the spillways is open and well vegetated with adapted grasses for 100 feet or more below the spillway outlets where it enters a side drainageway for an adjacent watershed. No erosion was observed in the exit channel. The side drainage outlet is overgrown with trees and brush, but this should not affect spillway operations.

3.2 EVALUATION

The upstream slope and the central portion (crest) of the dam appear to be in good condition. The downstream slope is in poor condition. The integrity of the dam is threatened by the dense growth of trees and brush and large rodent holes on the downstream slope. The abnormally steep downstream slope (1H on 1.5H) and the nature of the surface materials (CL-ML) would indicate that overtopping of the dam could result in significant damage and possible breaching. Seepage through the foundation of the dam does not appear to adversely affect the stability of the structure. The spillways are in good condition, and spillway discharges will not affect the dam in anyway.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

Maintenance on the crest and upstream slope of the dam appears to be very good. There has been no apparent maintenance of the downstream slope, which was undoubtedly covered with trees and brush when the old railroad fill was converted to an impounding structure.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

The lack of maintenance of the downstream slope, as evidenced by the heavy growth of trees and brush and the existence of large rodent holes, could ultimately lead to failure of this dam.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data were found for this dam.

b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Labadie, Missouri 7½ minute topographic quadrangle map. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection. Hydraulic/hydrologic computations are included as Appendix D of this report.

c. Visual Observations.

(1) The spillways are located almost due east of the right (north) abutment of the dam on the ridge line that defines the drainage area boundary of the dam. Spillway discharges will flow across the ridge line into a drainageway lying to the north of the dam and reservoir. The spillways appear to be in good condition. Spillway discharges will not endanger the dam.

(2) There are no drawdown facilities to evacuate the pool.

d. Overtopping Potential. The spillways are too small to pass 50% of the probable maximum flood without overtopping the dam. The spillways will pass the 1% probability flood as well as 24% of the probable maximum flood without overtopping. Overtopping is dangerous because the flow of water over the crest could erode the face of the dam and, if continued long enough, could breach the dam with sudden release of all of the impounded water into the downstream flood plain. The results of the routings through the dam are tabulated in regards to the following conditions:

Frequency	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	* Maximum Depth Over Dam Feet	Duration Over Top Hours
1%	225	15	572.7	0	0
1/2 PMF	490	420	574.3	0.6	4-
PMF	980	930	574.6	0.9	6-
0.24 PMF	235	50	573.7	0	0

*Minimum top of dam elevation - 573.7

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard potential rating and a small size. Therefore, the 1/2 PMF to PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in Paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. Based on visual observation this dam appears to be structurally stable; however, it was not possible to adequately observe much of the downstream slope for cracks, slides, deformations or seeps because of the dense cover of trees and shrubs. The downstream slope is abnormally steep for a dam of this height and observable composition. The nature of materials placed in the old railroad fill is not known. It could consist of quite granular material brought in from other required excavation along the railroad right-of-way. This could account for the lack of observable seepage on the downstream slope of the dam (control of the phreatic line) and would improve the safety factors for slope stability with respect to shear strength and seepage. Trees and shrubs should be removed from the slope, and measures should be taken to prevent their recurrence. Slope conditions should be re-evaluated after it has been cleared.

b. Design and Construction Data. No design or construction data were available for this dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. There are no controlled operating facilities for this dam. Mr. Brown reported that the principal spillway has operated at maximum capacity.

d. Post Construction Changes. The inspection team is not aware of any post construction changes to this dam after the railroad fill was converted to an impounding structure.

e. Seismic Stability. This dam is located in Seismic Zone 2. An earthquake of the magnitude predicted in this area could be expected to cause significant damage to this dam with the present steep downstream slope and apparent ML-CL composition.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Based on visual observation this dam appears to be structurally stable. The upstream slope and the wide paved crest are in very good condition and are very well maintained. No signs of distress were observed on either the upstream slope or the crest which are the areas constructed in 1957 when the old railroad fill was changed into a dam. The downstream slope evidently was not altered during the conversion of the railroad fill to a dam as evidenced by the steep slope (1V on 1.5H) and the heavy growth of trees and brush. Although no evidence of slides, cracks, deformations, seepage or significant erosion were observed in the limited areas of the slope where observations could be made, these conditions could exist and could be masked by the heavy tree and brush growth. The spillway system of the dam is in good condition but does not have sufficient capacity to pass 50 percent of the probable maximum flood without overtopping the dam. Based on the abnormally steep downstream slope of the dam and on the surface materials (CL-ML) it would appear that overtopping could result in significant damage and possible breaching. The downstream slope should be cleared of all trees and brush. Continued growth could ultimately impair the structural stability of the dam and lead to failure. All rodent holes in the downstream slope should be repaired. Future maintenance should include the downstream slope with particular attention being given to prevention of tree and brush growth and curtailment of rodent activity. The seepage observed in the old stream channel paralleling the toe of the dam does not appear to have an adverse affect on the stability of the dam. However, after clearing the slope of trees and brush, it is recommended that the volume and nature of the seepage be monitored on a regular basis with particular attention being given to change in color and sediment content. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Due to the lack of engineering data, the conclusions in this report are based upon performance history and visual observations. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2b should be accomplished in the near future. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Further Investigations. The additional studies and analyses recommended in paragraph 7.2b should be accomplished by the owner in the near future.

e. Seismic Stability. This dam is located in Seismic Zone 2. An earthquake of this magnitude could cause significant damage to the steep downstream slope of this dam. Stability analyses performed for this dam should include the appropriate Seismic Zone 2 earthquake loadings.

7.2 REMEDIAL MEASURES

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a registered professional engineer experienced in the design and construction of earth dams.

a. Alternatives.

(1) The height of the dam and/or the size of the spillways should be increased to prevent overtopping by 50% of the Probable Maximum Flood. In either case, the spillways should be protected to prevent erosion.

b. Operation and Maintenance Procedures.

(1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams. These analyses should include the appropriate Seismic Zone 2 earthquake loadings.

(2) Trees and brush should be removed from the downstream slope. Tree removal should be done under the guidance of an engineer experienced in the design and construction of dams.

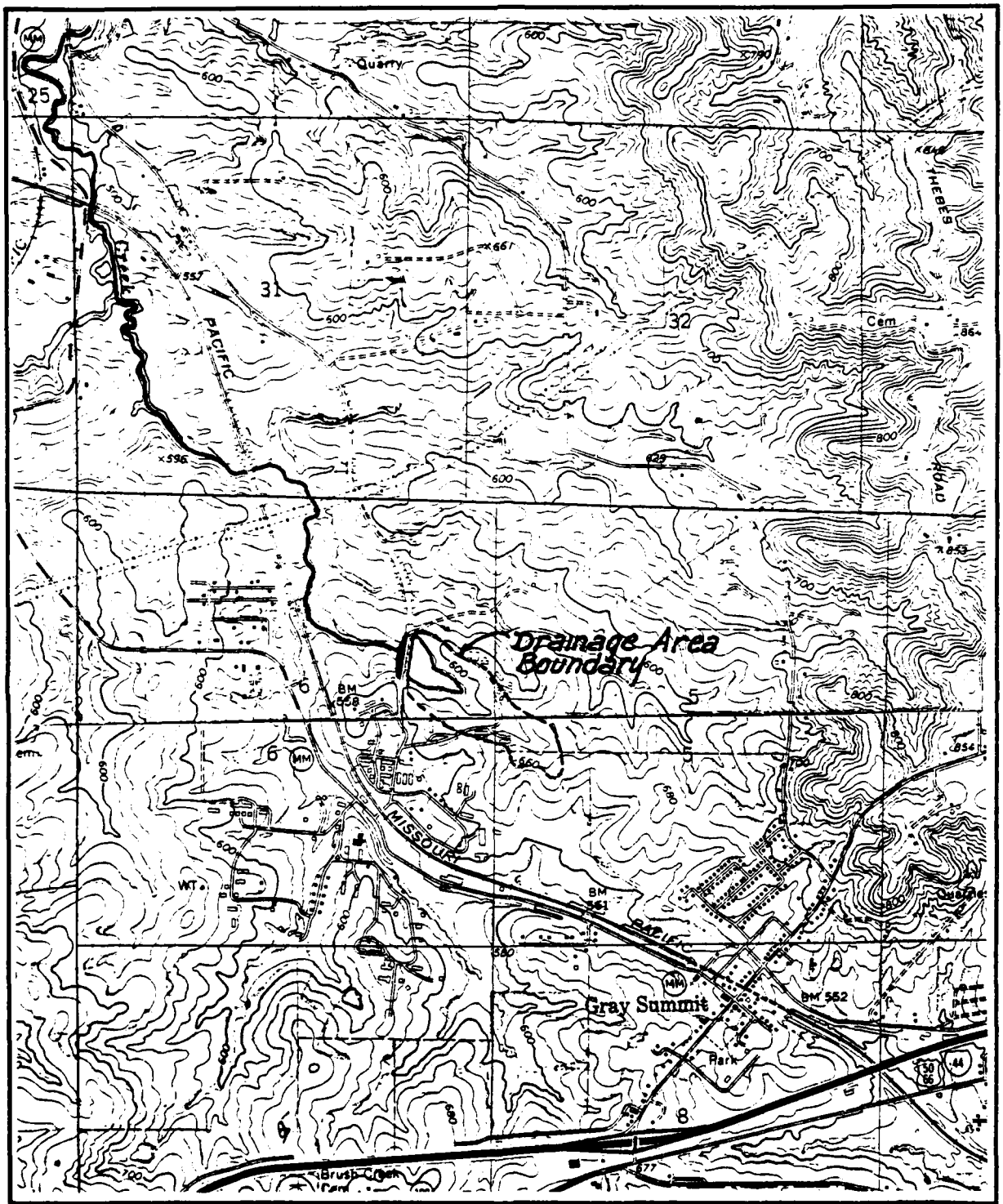
(3) The downstream slope should be inspected and reevaluated after removal of the trees and brush.

(4) Rodent holes on the downstream slope should be repaired.

(5) The amount and nature (color, sediment, etc.) of the seepage effluent should be monitored on a regular basis, particularly under maximum reservoir levels.

(6) A program of regular inspection and maintenance should be initiated with inspection reports made a part of this project file. Inspection and maintenance operations should include observations on seepage, prevention of tree growth and curtailment of rodent activity.

APPENDIX A
MAPS



Scale in feet

2000 1000 0 2000 4000

Contour Interval - 20'

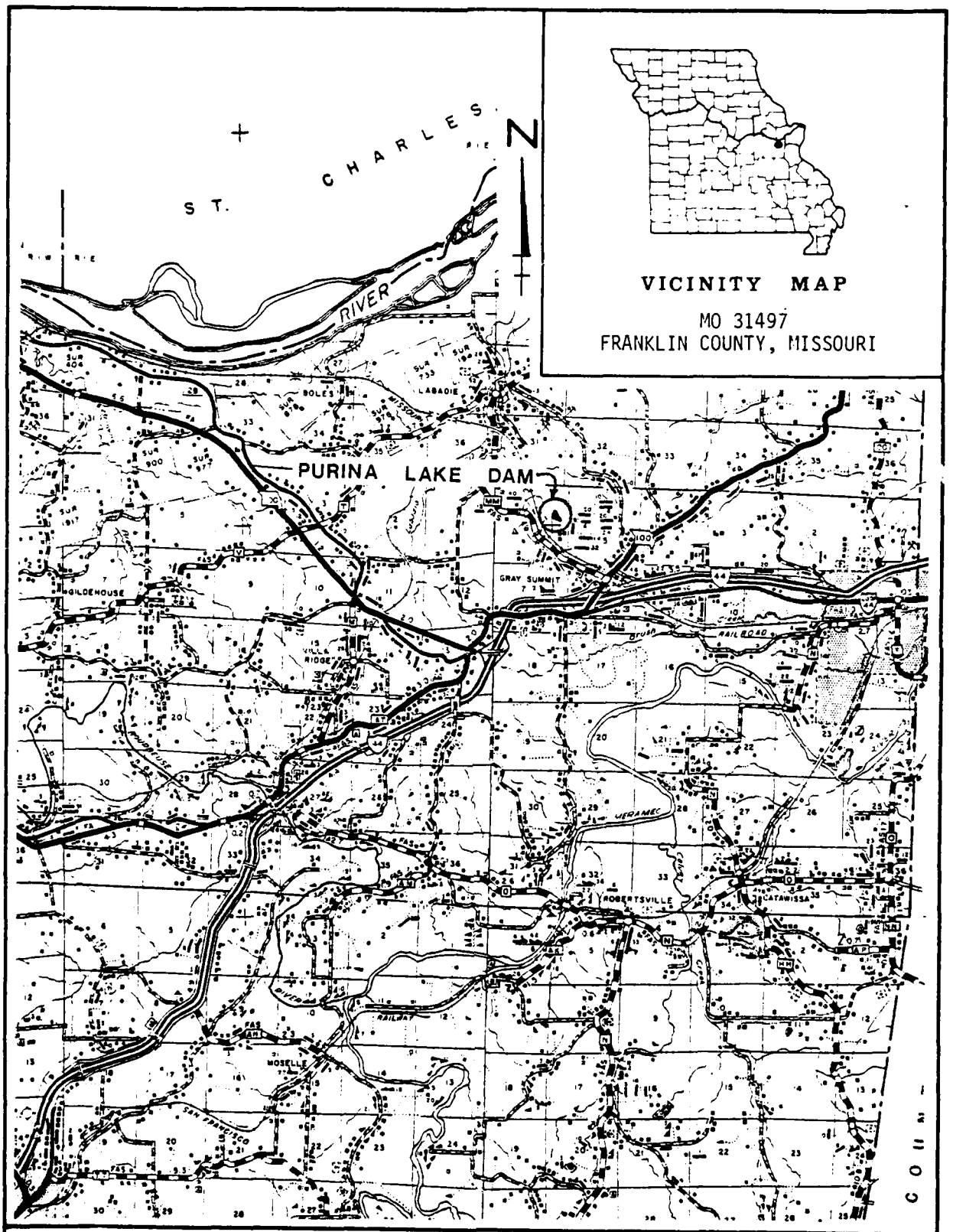
N

VICINITY TOPOGRAPHY

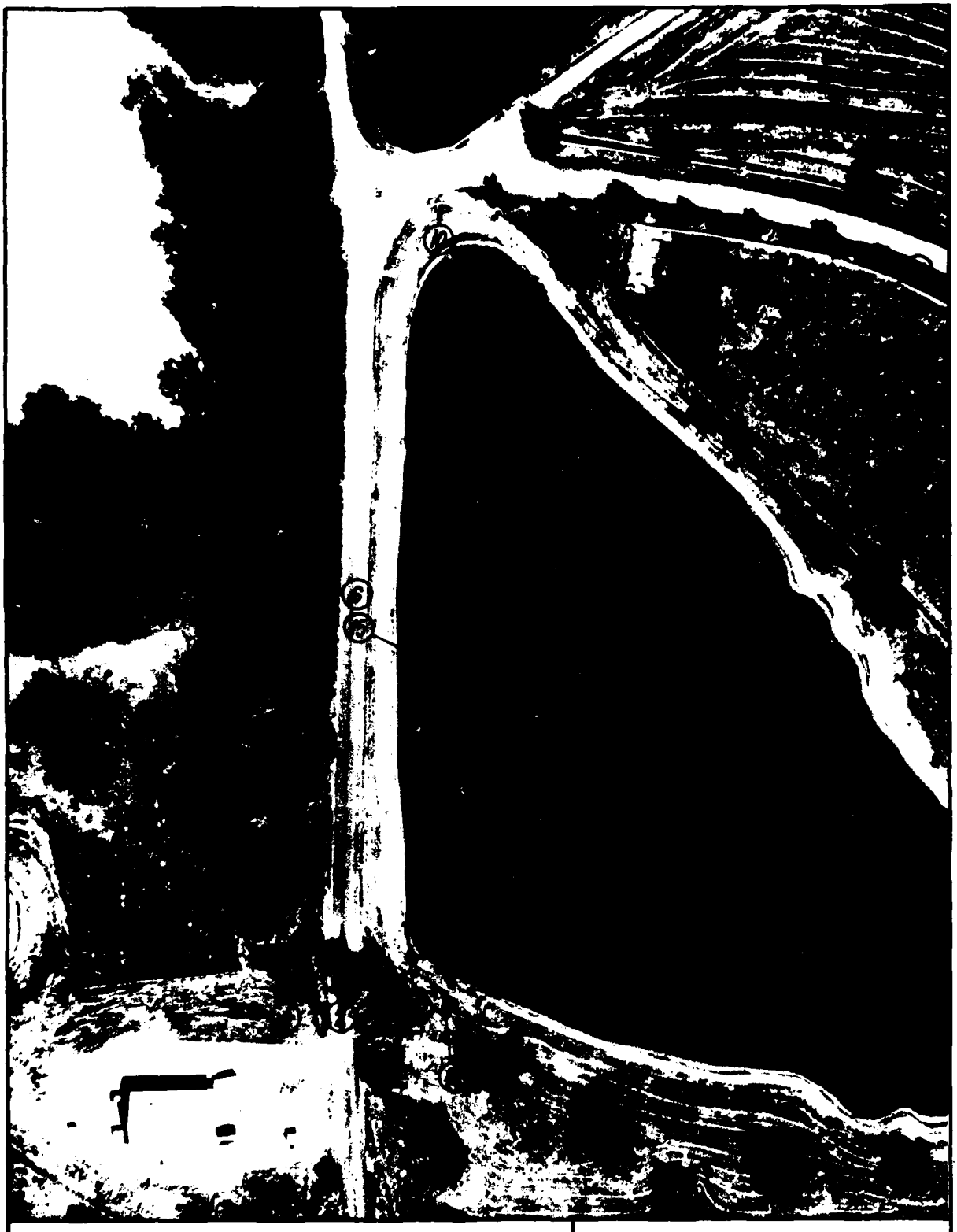
PURINA LAKE DAM

FRANKLIN COUNTY, MO.

MO 31497 **PLATE A-1**


VICINITY MAP
MO 31497
FRANKLIN COUNTY, MISSOURI
ST. CHARLES
RIVER
PURINA LAKE DAM
GILDEHOUSE
GRAY SUMMIT
ROBERTSVILLE
CATAWISSA
MOSELLE
MERAMEC
RAILROAD
Scale in miles
0 1 2 3 4 5
LOCATION MAP
PLATE A-2

APPENDIX B
PHOTOGRAPHS



PURINA LAKE DAM
FRANKLIN COUNTY, MISSOURI
MO 31497

PHOTO INDEX

PLATE B-1

PHOTO NO. 2 - CREST TAKEN FROM LEFT ABUTMENT

PHOTO NO. 3 - UPSTREAM SLOPE TAKEN FROM LEFT SIDE

PHOTO NO. 4 - DOWNSTREAM SLOPE TAKEN FROM LEFT SIDE

PHOTO NO. 5 - DOWNSTREAM SLOPE TAKEN FROM RIGHT SIDE

PHOTO NO. 6 - DOWNSTREAM SLOPE TAKEN FROM CREST AT ABOUT STA. 3+50

PHOTO NO. 7 - SEEPAGE IN OLD CHANNEL ALONG THE TOE OF DAM AT ABOUT STA. 3+50

PHOTO NO. 8 - TOE OF DAM AT STA. 3+50

PHOTO NO. 9 - RODENT BURROW APPROXIMATELY 5 TO 6 FEET ABOVE THE TOE

PHOTO NO. 10 - INLET END OF PRINCIPAL SPILLWAY CONSISTING OF TWO 18-INCH CORRUGATED METAL PIPE CULVERTS AND CONCRETE HEADWALL. PAVED ROAD CROSSING CULVERTS IS THE EMERGENCY SPILLWAY

PHOTO NO. 11 - OUTLET OF SPILLWAY

PHOTO NO. 12 - DOWNSTREAM OF SPILLWAY OUTLET

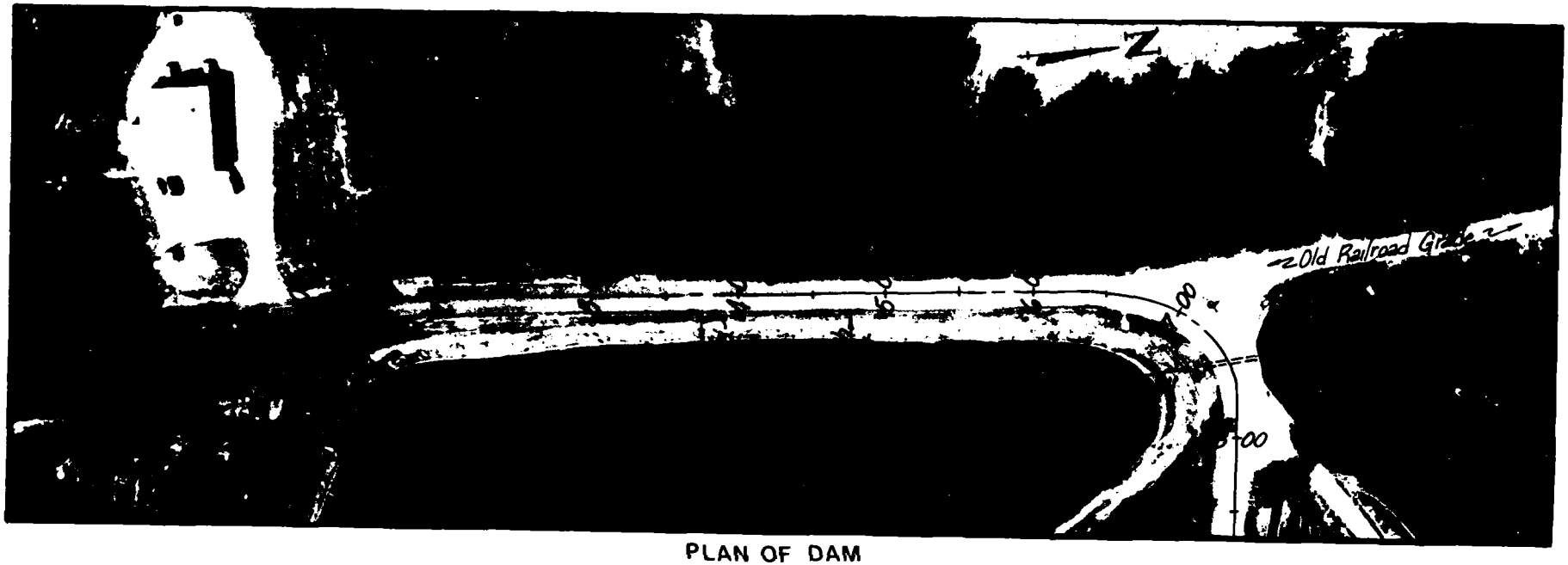
PHOTO NO. 13 - OVERVIEW FROM THE RIGHT SIDE

PHOTO NO. 14 - OVERVIEW FROM THE LEFT SIDE

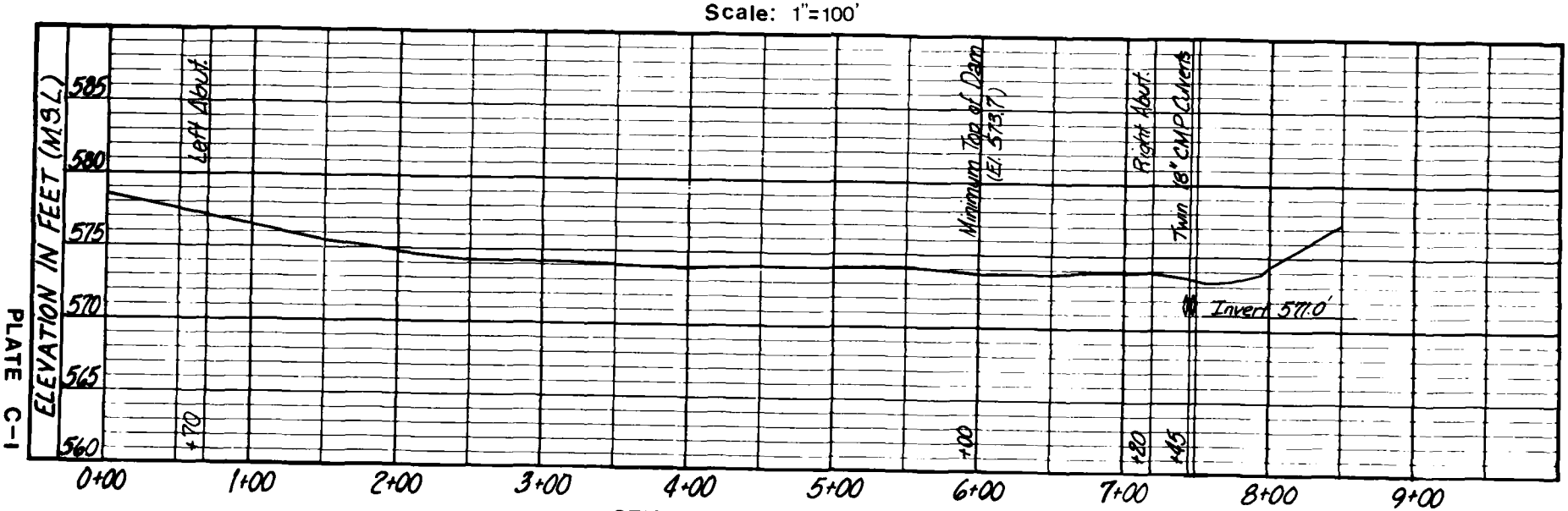
PHOTO NO. 15 - VIEW LOOKING UPSTREAM INTO THE RESERVOIR
TAKEN FROM THE CREST AT ABOUT STA. 3+50

PHOTO NO. 16 - HOUSE LOCATED NEAR CREEK APPROXIMATELY 1.5 MILES DOWNSTREAM OF DAM

APPENDIX C
PROJECT PLATES

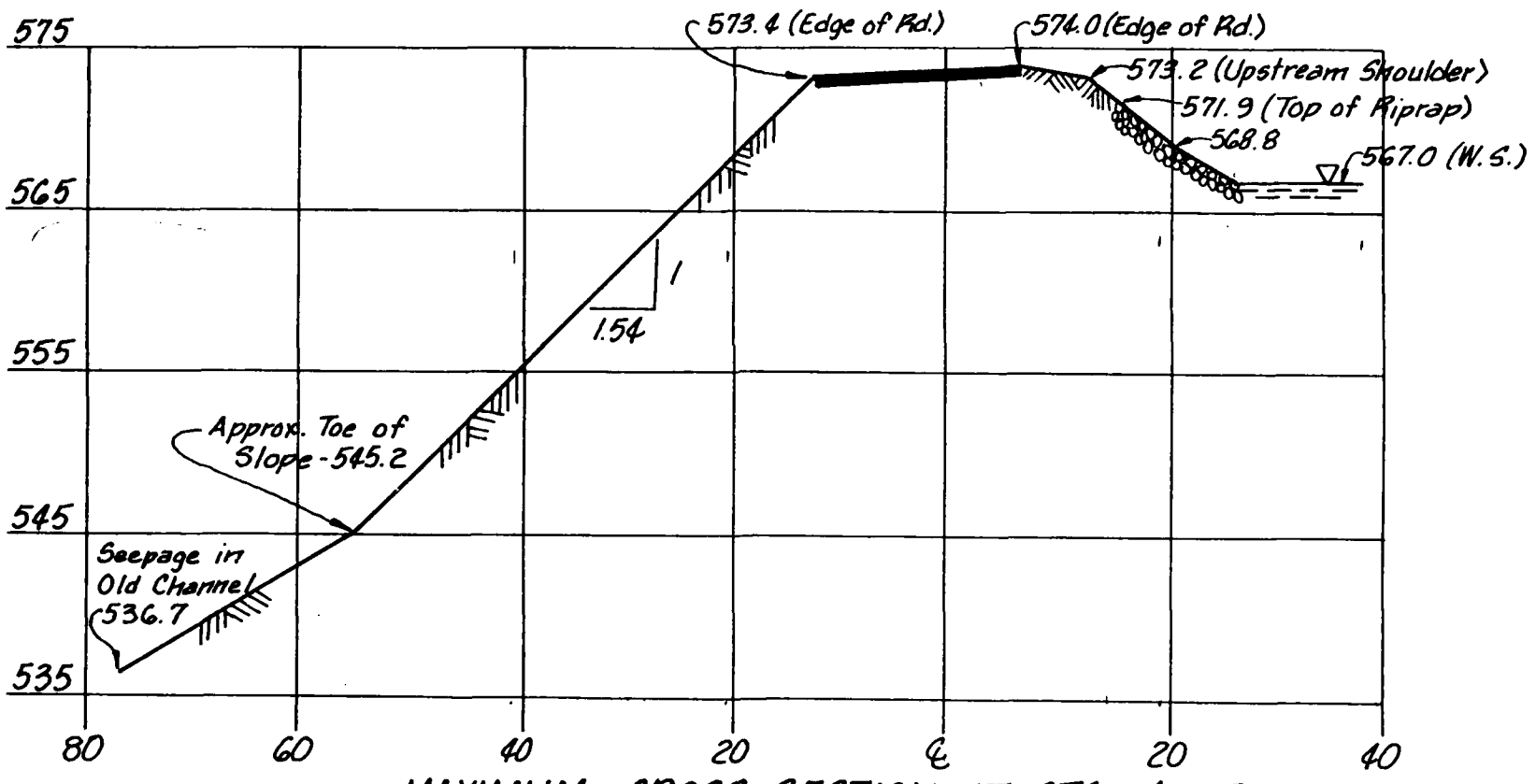


PLAN OF DAM
Scale: 1"=100'



CENTERLINE PROFILE OF DAM
Scale As Shown

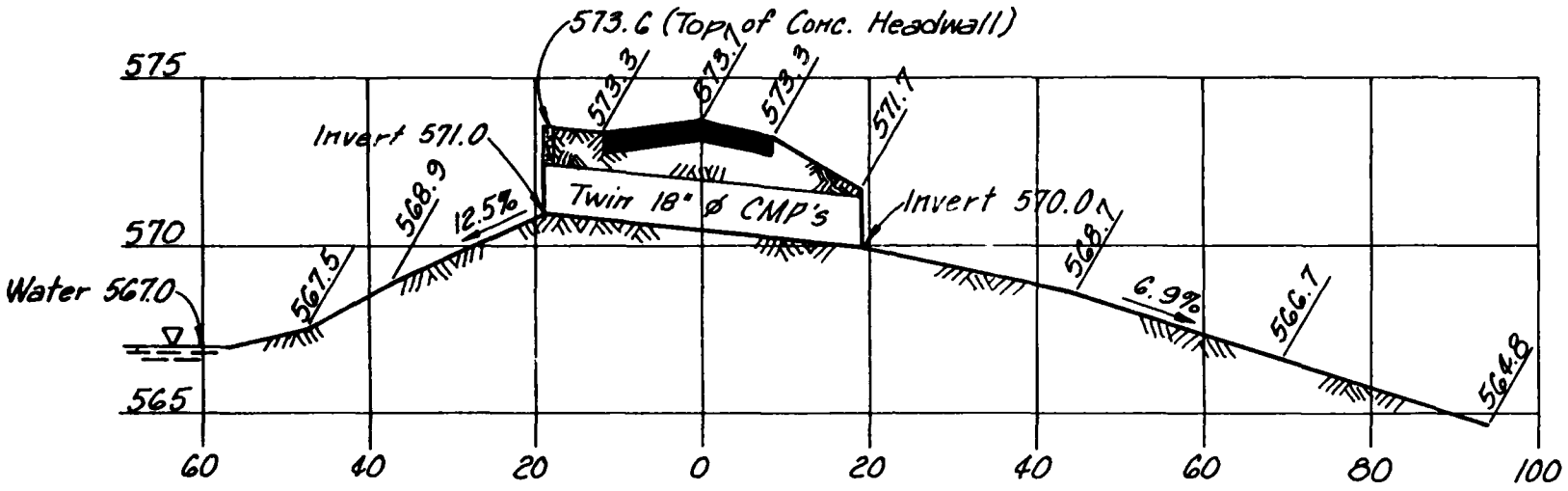
PLATE C-1



MAXIMUM CROSS-SECTION AT STA. 4+25

Scale: 1" = 15' H
1" = 10' V

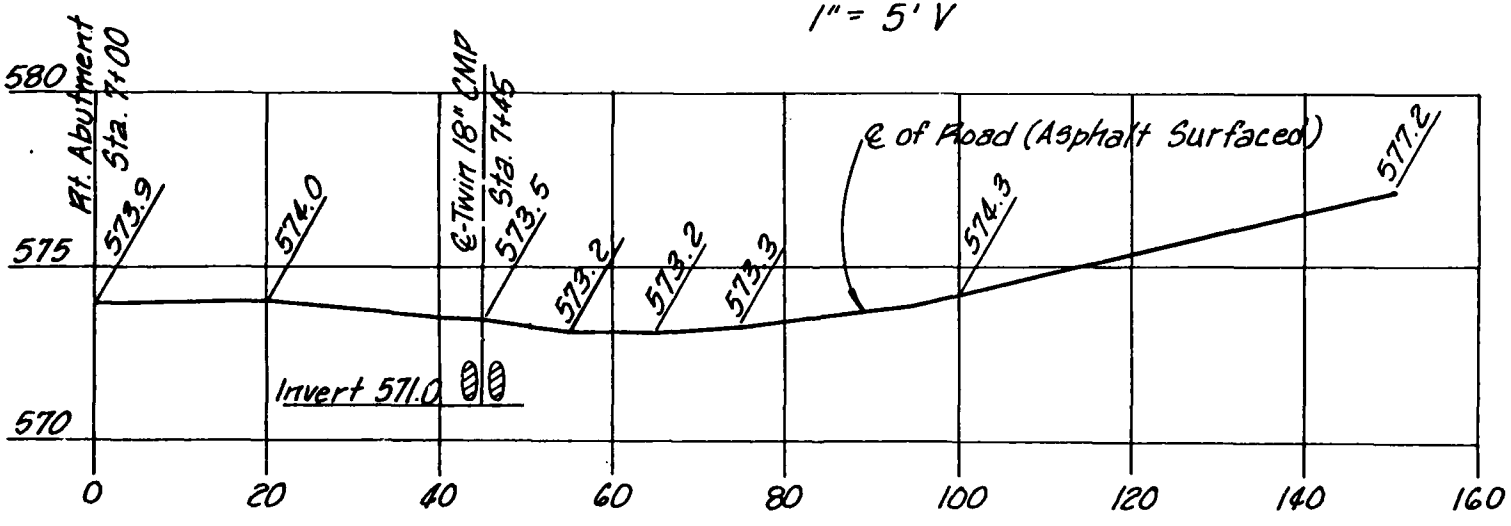
PLATE C-2



CENTERLINE PROFILE OF SPILLWAY

Scale: 1" = 20' H

1" = 5' V



SPILLWAY CROSS-SECTION ALONG ℄ ROAD

Scale: 1" = 20' H

1" = 5' V

PLATE C-3

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (See this Section).

   a. Twenty-four hour, one percent probabilistic rainfall for the dam location was taken from the data for the rainfall station at Sullivan, Missouri as supplied by the St. Louis District, Corps of Engineers per their letter dated 6 March 1979. The twenty-four hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.

   b. Drainage area = 0.069 square miles (44 acres).

   c. Time of concentration of runoff = 12 minutes (computed from the "Kirpich" formula and verified using the equation from California Culverts Practice, California Highways and Public Works, September 1942).

   d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the one percent probabilistic precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). Using the antecedent flood conditions, the initial pool elevation was assumed at the invert of the principal spillway (twin 18" CMP culverts).

   e. The total twenty-four hour storm duration losses for the one percent probabilistic storm were 2.88 inches. The total losses for the PMF storm were 1.58 inches. These data are based on SCS runoff curve No. 75 and No. 88 for antecedent moisture conditions SCS AMC II and AMC III respectively. The watershed is composed of primarily SCS soil groups B and C (Menfro and Winfield soils respectively). The drainage area is primarily in pasture with a few acres covered with hard surface roads.

   f. Average soil loss rates = 0.06 inch per hour approximately (For PMF storm, AMC III).

2. The combined discharge rating consisted of three components: the flow through the principal spillway, the flow through the emergency spillway and the flow going over the top of the dam.

   a. The principal spillway rating was developed by using culvert flow tables for CMP culverts with inlet control and outlet control as found in FHA-BRP HEC Circ. No. 5. It was assumed that no appreciable debris would develop to hinder flow through the principal spillway.

b. The emergency spillway rating was developed by computing flow over highway embankments with methods and coefficients found in USGS TWRI, Bk. 3, Ch. A5 "Measurement of Peak Discharge at Dams by Indirect Methods". Weir coefficients varied with head and ranged from 2.97 to 3.06.

c. The flows over the dam were determined by using the dam overtopping analyses (irregular top of dam) within the HEC-1 (Dam Safety Version) program.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The input, output and plotted hydrographs are attached in this Section.

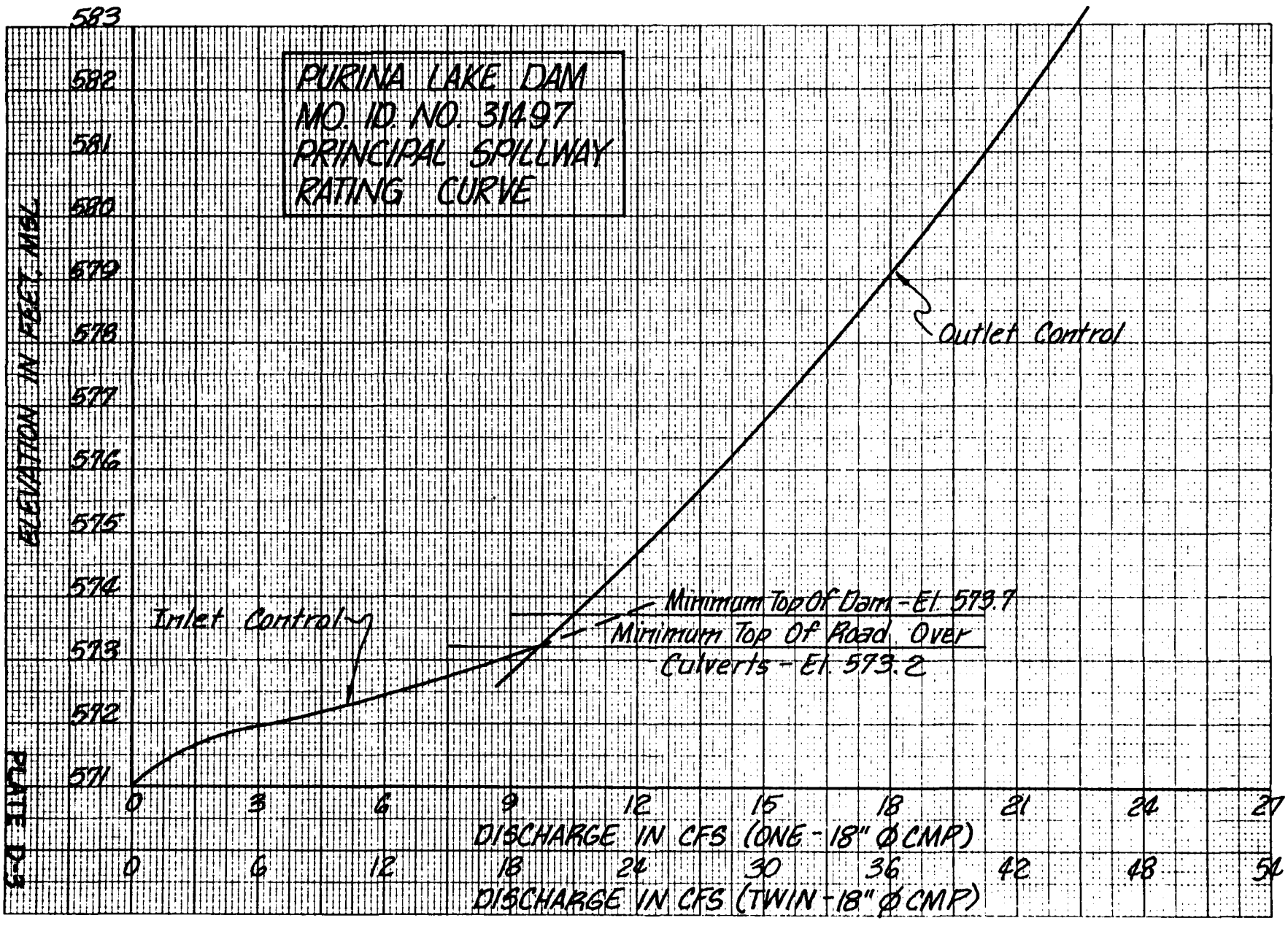


PLATE D-5

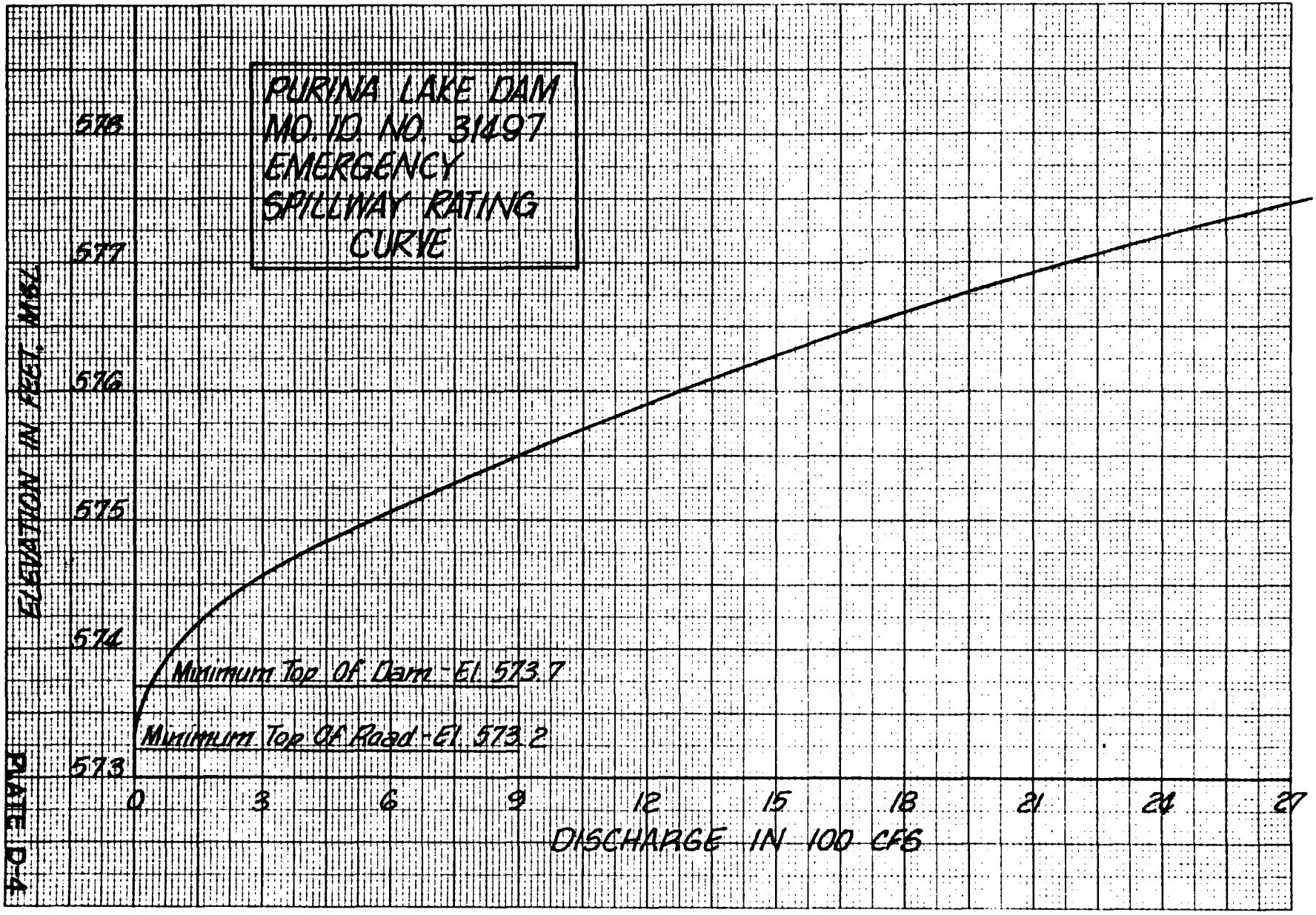
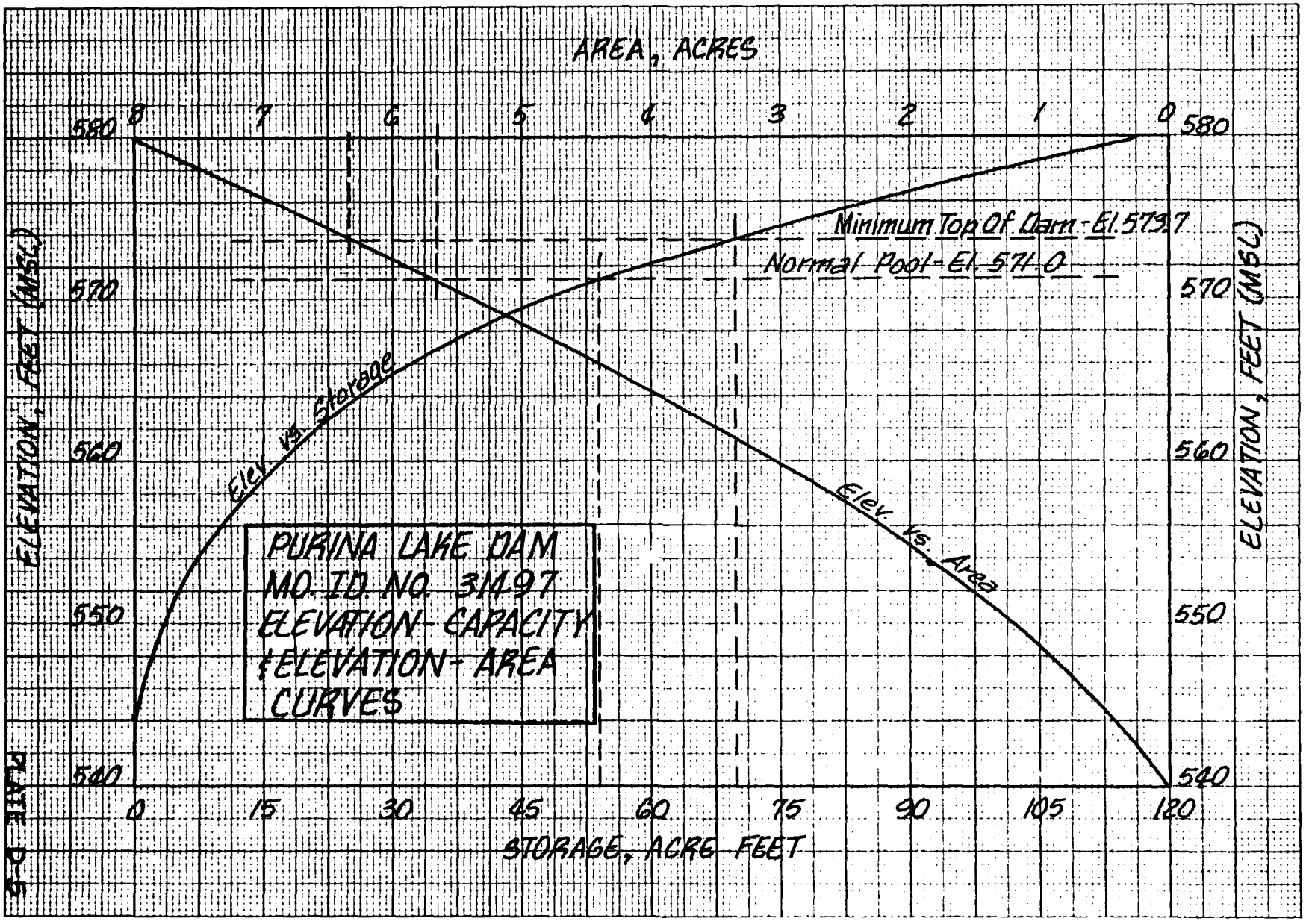


PLATE D-4



CARD DATA INPUT LISTING

```
A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2       H & H ANALYSIS OF SAFETY OF PURINA CARE 31497
A3       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR
B 000208000000000000005                                  000000000000000000000003
B1000005
J 000001000000800000001
J1000,2000000,2100000.2200000.2300000,2400000,2500000,50000001,000000000
K 00000000000001                                         000000000000000000000001
K1       CALCULATION OF INFLOW HYDROGRAPH TO RESERVOIR 31497
M 000001000000020000,069          0000.069000001.0                        00000001
P        000025,5000001020000012100000130
T                                                                -1.0    -88.0
W2000,17
X 000000     -,0100000001
K 00000100000002                                         000000020000000000000001
K1       ROUTED FLOWS THROUGH RESERVOIR 31497
Y                                 0000000100000001
Y1000001                                                        -571.0       -1
Y40571.0000572.0000573.0000573.5000574.0000574.2000574.4000574.7000575.0000576.0
Y40577.0000577,5
Y5000000000000070000001600000020000001070000017400000258000004090000058500001311
Y500221900002788
$A00000000005,6200008,0300011,82
$E0542,0000571,0000058000000590
$$0571,0
$D0573,7000002,9000001,500000650
$L000050000001250000020500000400000004600000048500000510000005800000063000000650
$V0573,7000573,9000574,0000574,2000574,4000574,7000575,0000576,0000577,0000577,5
K 000099
A
A
A
A
A
```

PLATE D-6

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************

RUN  DATE= 80/10/22.
     TIME= 13.55.12.
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
H & H ANALYSIS OF SAFETY OF PURINA LAKE 31497
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	3	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 8 LRTIO= 1

RTIOS=	.20	.21	.22	.23	.24	.25	.50	1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH TO RESERVOIR 31497

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000001	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.07	0.00	.07	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.50	102.00	121.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-88.00	0.00	0.00

CURVE NO = -88.00 WETNESS = -1.00 EFFECT CN = 88.00

UNIT HYDROGRAPH DATA
TC= .17 LAG= .10

RECESSION DATA
STRTQ= 0.00 QRCSN= -.01 RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 8 END OF PERIOD ORDINATES, TC= .17 HOURS, LAG= .10 VOL= 1.00

145.	223.	101.	40.	15.	6.	2.	1.

PLATE D-7

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.22	.21	.01	55.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.22	.21	.01	88.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.22	.21	.01	102.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.22	.21	.01	108.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.22	.21	.01	111.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.22	.21	.01	112.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.22	.21	.01	112.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.22	.21	.01	113.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.22	.21	.01	113.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.22	.21	.01	113.
1.01	.55	11	.01	0.00	.01	0.	1.01	12.55	155	.22	.21	.00	113.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.00	156	.22	.21	.00	113.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.05	157	.26	.25	.01	119.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.10	158	.26	.26	.00	129.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.15	159	.26	.26	.00	133.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.20	160	.26	.26	.00	135.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.25	161	.26	.26	.00	136.
1.01	1.30	18	.01	0.00	.01	0.	1.01	13.30	162	.26	.26	.00	136.
1.01	1.35	19	.01	0.00	.01	0.	1.01	13.35	163	.26	.26	.00	137.
1.01	1.40	20	.01	0.00	.01	0.	1.01	13.40	164	.26	.26	.00	137.
1.01	1.45	21	.01	0.00	.01	0.	1.01	13.45	165	.26	.26	.00	137.
1.01	1.50	22	.01	.00	.01	0.	1.01	13.50	166	.26	.26	.00	137.
1.01	1.55	23	.01	.00	.01	0.	1.01	13.55	167	.26	.26	.00	137.
1.01	2.00	24	.01	.00	.01	0.	1.01	14.00	168	.26	.26	.00	137.
1.01	2.05	25	.01	.00	.01	0.	1.01	14.05	169	.33	.32	.00	147.
1.01	2.10	26	.01	.00	.01	0.	1.01	14.10	170	.33	.32	.00	161.
1.01	2.15	27	.01	.00	.01	0.	1.01	14.15	171	.33	.32	.00	168.
1.01	2.20	28	.01	.00	.01	1.	1.01	14.20	172	.33	.32	.00	170.
1.01	2.25	29	.01	.00	.01	1.	1.01	14.25	173	.33	.32	.00	171.
1.01	2.30	30	.01	.00	.01	1.	1.01	14.30	174	.33	.32	.00	172.
1.01	2.35	31	.01	.00	.01	1.	1.01	14.35	175	.33	.32	.00	172.
1.01	2.40	32	.01	.00	.01	1.	1.01	14.40	176	.33	.32	.00	172.
1.01	2.45	33	.01	.00	.01	1.	1.01	14.45	177	.33	.32	.00	172.
1.01	2.50	34	.01	.00	.01	1.	1.01	14.50	178	.33	.32	.00	172.
1.01	2.55	35	.01	.00	.01	1.	1.01	14.55	179	.33	.32	.00	172.
1.01	3.00	36	.01	.00	.01	1.	1.01	15.00	180	.33	.32	.00	172.
1.01	3.05	37	.01	.00	.01	1.	1.01	15.05	181	.20	.20	.00	154.
1.01	3.10	38	.01	.00	.01	2.	1.01	15.10	182	.40	.39	.00	154.
1.01	3.15	39	.01	.00	.01	2.	1.01	15.15	183	.40	.39	.00	185.
1.01	3.20	40	.01	.00	.01	2.	1.01	15.20	184	.59	.59	.00	229.
1.01	3.25	41	.01	.00	.01	2.	1.01	15.25	185	.69	.69	.00	293.
1.01	3.30	42	.01	.00	.01	2.	1.01	15.30	186	1.68	1.67	.01	480.
1.01	3.35	43	.01	.00	.01	2.	1.01	15.35	187	2.77	2.76	.01	876.
1.01	3.40	44	.01	.00	.01	2.	1.01	15.40	188	1.09	1.08	.00	981.
1.01	3.45	45	.01	.00	.01	2.	1.01	15.45	189	.69	.69	.00	703.
1.01	3.50	46	.01	.00	.01	2.	1.01	15.50	190	.59	.59	.00	491.
1.01	3.55	47	.01	.00	.01	2.	1.01	15.55	191	.40	.39	.00	357.
1.01	4.00	48	.01	.00	.01	2.	1.01	16.00	192	.40	.39	.00	270.
1.01	4.05	49	.01	.00	.01	2.	1.01	16.05	193	.30	.30	.00	221.
1.01	4.10	50	.01	.00	.01	2.	1.01	16.10	194	.30	.30	.00	185.
1.01	4.15	51	.01	.00	.01	3.	1.01	16.15	195	.30	.30	.00	170.
1.01	4.20	52	.01	.00	.01	3.	1.01	16.20	196	.30	.30	.00	165.
1.01	4.25	53	.01	.01	.01	3.	1.01	16.25	197	.30	.30	.00	163.
1.01	4.30	54	.01	.01	.01	3.	1.01	16.30	198	.30	.30	.00	162.
1.01	4.35	55	.01	.01	.01	3.	1.01	16.35	199	.30	.30	.00	162.
1.01	4.40	56	.01	.01	.01	3.	1.01	16.40	200	.30	.30	.00	162.
1.01	4.45	57	.01	.01	.01	3.	1.01	16.45	201	.30	.30	.00	162.
1.01	4.50	58	.01	.01	.01	3.	1.01	16.50	202	.30	.30	.00	162.
1.01	4.55	59	.01	.01	.01	3.	1.01	16.55	203	.30	.30	.00	162.

PLATE D-8

1.01	5.00	60	.01	.01	.01	3.	1.01	17.00	204	.30	.30	.00	162.
1.01	5.05	61	.01	.01	.01	3.	1.01	17.05	205	.24	.24	.00	152.
1.01	5.10	62	.01	.01	.01	3.	1.01	17.10	206	.24	.24	.00	138.
1.01	5.15	63	.01	.01	.01	3.	1.01	17.15	207	.24	.24	.00	131.
1.01	5.20	64	.01	.01	.01	3.	1.01	17.20	208	.24	.24	.00	129.
1.01	5.25	65	.01	.01	.01	3.	1.01	17.25	209	.24	.24	.00	128.
1.01	5.30	66	.01	.01	.01	3.	1.01	17.30	210	.24	.24	.00	127.
1.01	5.35	67	.01	.01	.01	3.	1.01	17.35	211	.24	.24	.00	127.
1.01	5.40	68	.01	.01	.01	3.	1.01	17.40	212	.24	.24	.00	127.
1.01	5.45	69	.01	.01	.01	3.	1.01	17.45	213	.24	.24	.00	127.
1.01	5.50	70	.01	.01	.01	4.	1.01	17.50	214	.24	.24	.00	127.
1.01	5.55	71	.01	.01	.01	4.	1.01	17.55	215	.24	.24	.00	127.
1.01	6.00	72	.01	.01	.01	4.	1.01	18.00	216	.24	.24	.00	127.
1.01	6.05	73	.07	.04	.03	8.	1.01	18.05	217	.02	.02	.00	95.
1.01	6.10	74	.07	.04	.03	15.	1.01	18.10	218	.02	.02	.00	46.
1.01	6.15	75	.07	.04	.03	19.	1.01	18.15	219	.02	.02	.00	24.
1.01	6.20	76	.07	.04	.02	21.	1.01	18.20	220	.02	.02	.00	16.
1.01	6.25	77	.07	.04	.02	22.	1.01	18.25	221	.02	.02	.00	12.
1.01	6.30	78	.07	.05	.02	23.	1.01	18.30	222	.02	.02	.00	11.
1.01	6.35	79	.07	.05	.02	24.	1.01	18.35	223	.02	.02	.00	10.
1.01	6.40	80	.07	.05	.02	25.	1.01	18.40	224	.02	.02	.00	10.
1.01	6.45	81	.07	.05	.02	25.	1.01	18.45	225	.02	.02	.00	10.
1.01	6.50	82	.07	.05	.02	26.	1.01	18.50	226	.02	.02	.00	10.
1.01	6.55	83	.07	.05	.02	26.	1.01	18.55	227	.02	.02	.00	10.
1.01	7.00	84	.07	.05	.02	27.	1.01	19.00	228	.02	.02	.00	10.
1.01	7.05	85	.07	.05	.02	27.	1.01	19.05	229	.02	.02	.00	10.
1.01	7.10	86	.07	.05	.01	28.	1.01	19.10	230	.02	.02	.00	10.
1.01	7.15	87	.07	.05	.01	28.	1.01	19.15	231	.02	.02	.00	10.
1.01	7.20	88	.07	.05	.01	28.	1.01	19.20	232	.02	.02	.00	10.
1.01	7.25	89	.07	.05	.01	29.	1.01	19.25	233	.02	.02	.00	10.
1.01	7.30	90	.07	.05	.01	29.	1.01	19.30	234	.02	.02	.00	10.
1.01	7.35	91	.07	.06	.01	29.	1.01	19.35	235	.02	.02	.00	10.
1.01	7.40	92	.07	.06	.01	30.	1.01	19.40	236	.02	.02	.00	10.
1.01	7.45	93	.07	.06	.01	30.	1.01	19.45	237	.02	.02	.00	10.
1.01	7.50	94	.07	.06	.01	30.	1.01	19.50	238	.02	.02	.00	10.
1.01	7.55	95	.07	.06	.01	30.	1.01	19.55	239	.02	.02	.00	10.
1.01	8.00	96	.07	.06	.01	30.	1.01	20.00	240	.02	.02	.00	10.
1.01	8.05	97	.07	.06	.01	31.	1.01	20.05	241	.02	.02	.00	10.
1.01	8.10	98	.07	.06	.01	31.	1.01	20.10	242	.02	.02	.00	10.
1.01	8.15	99	.07	.06	.01	31.	1.01	20.15	243	.02	.02	.00	10.
1.01	8.20	100	.07	.06	.01	31.	1.01	20.20	244	.02	.02	.00	10.
1.01	8.25	101	.07	.06	.01	31.	1.01	20.25	245	.02	.02	.00	10.
1.01	8.30	102	.07	.06	.01	32.	1.01	20.30	246	.02	.02	.00	10.
1.01	8.35	103	.07	.06	.01	32.	1.01	20.35	247	.02	.02	.00	10.
1.01	8.40	104	.07	.06	.01	32.	1.01	20.40	248	.02	.02	.00	10.
1.01	8.45	105	.07	.06	.01	32.	1.01	20.45	249	.02	.02	.00	10.
1.01	8.50	106	.07	.06	.01	32.	1.01	20.50	250	.02	.02	.00	10.
1.01	8.55	107	.07	.06	.01	32.	1.01	20.55	251	.02	.02	.00	10.
1.01	9.00	108	.07	.06	.01	32.	1.01	21.00	252	.02	.02	.00	10.
1.01	9.05	109	.07	.06	.01	32.	1.01	21.05	253	.02	.02	.00	10.
1.01	9.10	110	.07	.06	.01	33.	1.01	21.10	254	.02	.02	.00	10.
1.01	9.15	111	.07	.06	.01	33.	1.01	21.15	255	.02	.02	.00	10.
1.01	9.20	112	.07	.06	.01	33.	1.01	21.20	256	.02	.02	.00	10.
1.01	9.25	113	.07	.06	.01	33.	1.01	21.25	257	.02	.02	.00	10.
1.01	9.30	114	.07	.06	.01	33.	1.01	21.30	258	.02	.02	.00	10.
1.01	9.35	115	.07	.06	.01	33.	1.01	21.35	259	.02	.02	.00	10.
1.01	9.40	116	.07	.06	.01	33.	1.01	21.40	260	.02	.02	.00	10.
1.01	9.45	117	.07	.06	.00	33.	1.01	21.45	261	.02	.02	.00	10.
1.01	9.50	118	.07	.06	.00	33.	1.01	21.50	262	.02	.02	.00	10.
1.01	9.55	119	.07	.06	.00	33.	1.01	21.55	263	.02	.02	.00	10.
1.01	10.00	120	.07	.06	.00	33.	1.01	22.00	264	.02	.02	.00	10.
1.01	10.05	121	.07	.06	.00	33.	1.01	22.05	265	.02	.02	.00	10.

PLATE D-9

1.01	10.10	122	.07	.06	.00	34.	1.01	22.10	266	.02	.02	.00	10.
1.01	10.15	123	.07	.06	.00	34.	1.01	22.15	267	.02	.02	.00	10.
1.01	10.20	124	.07	.06	.00	34.	1.01	22.20	268	.02	.02	.00	10.
1.01	10.25	125	.07	.06	.00	34.	1.01	22.25	269	.02	.02	.00	10.
1.01	10.30	126	.07	.06	.00	34.	1.01	22.30	270	.02	.02	.00	10.
1.01	10.35	127	.07	.06	.00	34.	1.01	22.35	271	.02	.02	.00	10.
1.01	10.40	128	.07	.06	.00	34.	1.01	22.40	272	.02	.02	.00	10.
1.01	10.45	129	.07	.06	.00	34.	1.01	22.45	273	.02	.02	.00	10.
1.01	10.50	130	.07	.06	.00	34.	1.01	22.50	274	.02	.02	.00	10.
1.01	10.55	131	.07	.06	.00	34.	1.01	22.55	275	.02	.02	.00	10.
1.01	11.00	132	.07	.06	.00	34.	1.01	23.00	276	.02	.02	.00	10.
1.01	11.05	133	.07	.06	.00	34.	1.01	23.05	277	.02	.02	.00	10.
1.01	11.10	134	.07	.06	.00	34.	1.01	23.10	278	.02	.02	.00	10.
1.01	11.15	135	.07	.06	.00	34.	1.01	23.15	279	.02	.02	.00	10.
1.01	11.20	136	.07	.06	.00	34.	1.01	23.20	280	.02	.02	.00	10.
1.01	11.25	137	.07	.06	.00	34.	1.01	23.25	281	.02	.02	.00	10.
1.01	11.30	138	.07	.06	.00	34.	1.01	23.30	282	.02	.02	.00	10.
1.01	11.35	139	.07	.06	.00	34.	1.01	23.35	283	.02	.02	.00	10.
1.01	11.40	140	.07	.06	.00	34.	1.01	23.40	284	.02	.02	.00	10.
1.01	11.45	141	.07	.06	.00	34.	1.01	23.45	285	.02	.02	.00	10.
1.01	11.50	142	.07	.06	.00	34.	1.01	23.50	286	.02	.02	.00	10.
1.01	11.55	143	.07	.06	.00	34.	1.01	23.55	287	.02	.02	.00	10.
1.01	12.00	144	.07	.06	.00	34.	1.02	0.00	288	.02	.02	.00	10.
									SUM	33.15	31.57	1.58	16829.
										(842.)	(802.)	(40.)	(476.54)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	981.	190.	58.	58.	16842.
CMS	28.	5.	2.	2.	477.
INCHES		25.62	31.53	31.53	31.53
MM		650.73	800.99	800.99	800.99
AC-FT		94.	116.	116.	116.
THOUS CU M		116.	143.	143.	143.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	196.	38.	12.	12.	3368.
CMS	6.	1.	0.	0.	95.
INCHES		5.12	6.31	6.31	6.31
MM		130.15	160.20	160.20	160.20
AC-FT		19.	23.	23.	23.
THOUS CU M		23.	29.	29.	29.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	206.	40.	12.	12.	3537.
CMS	6.	1.	0.	0.	100.
INCHES		5.38	6.62	6.62	6.62
MM		136.65	168.21	168.21	168.21
AC-FT		20.	24.	24.	24.
THOUS CU M		24.	30.	30.	30.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 3

```
          CFS       981.      190.       58.       58.       16842.
          CMS        28.        5.        2.        2.         477.
       INCHES                 25.62     31.53     31.53        31.53
           MM                650.73    800.99    800.99       800.99
        AC-FT                   94.      116.      116.         116.
   THOUS CU M                  116.      143.      143.         143.


  **********        **********        **********        **********        **********

                               HYDROGRAPH ROUTING

            ROUTED FLOWS THROUGH RESERVOIR 31497

                  ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                 000002       1       0       0       2       0       1       0       0
                                    ROUTING DATA
          QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP            LSTR
            0.0   0.000    0.00       1       1       0       0               0

                  NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                      1       0       0   0.000   0.000   0.000   -571.      -1

STAGE      571.00    572.00    573.00    573.50    574.00    574.20    574.40    574.70    575.00    576.00
           577.00    577.50

FLOW         0.00      7.00     18.00     20.00    107.00    174.00    258.00    409.00    585.00   1311.00
          2219.00   2788.00

SURFACE AREA=      0.        6.        8.       12.

    CAPACITY=      0.       54.      115.      214.

   ELEVATION=    542.      571.      580.      590.

                  CREL   SPWID    COQW    EXPW   ELEVL    COQL   CAREA    EXPL
                 571.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0

                                       DAM DATA
                                TOPEL    COQD    EXPD  DAMWID
                                573.7     2.9     1.5    650.

CREST LENGTH        50.      125.      205.      400.      460.      485.      510.      580.      630.      650.
AT OR BELOW
ELEVATION        573.7     573.9     574.0     574.2     574.4     574.7     575.0     576.0     577.0     577.5

                          STATION 000002, PLAN 1, RATIO 1

                          END-OF-PERIOD HYDROGRAPH ORDINATES

                                       OUTFLOW
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
        0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
```

STATION 000002, PLAN 1, RATIO 5 0.24 PMF

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	4.	4.	4.	4.	4.	4.	4.
5.	5.	5.	5.	5.	5.	6.	6.	6.	6.
7.	7.	7.	7.	8.	8.	8.	9.	9.	9.
10.	10.	10.	11.	11.	12.	12.	12.	13.	13.
13.	14.	14.	14.	15.	16.	18.	19.	20.	28.
41.	47.	49.	49.	48.	47.	45.	44.	44.	43.
42.	42.	41.	41.	40.	39.	38.	37.	36.	35.
35.	34.	33.	33.	33.	32.	31.	29.	26.	22.
20.	20.	20.	20.	20.	20.	20.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	18.	18.	18.	18.	18.	18.	18.	18.	18.
18.	17.	17.	17.	17.	17.	17.	16.	16.	16.
16.	16.	16.	15.	15.	15.	15.	15.	15.	14.
14.	14.	14.	14.	14.	14.	13.	13.	13.	13.
13.	13.	13.	13.	12.	12.	12.	12.		

STORAGE

54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	57.	57.	57.	57.	57.	57.
57.	57.	57.	57.	57.	57.	57.	57.	57.	57.
57.	57.	57.	57.	57.	57.	57.	50.	58.	58.
58.	58.	58.	59.	59.	59.	59.	59.	59.	59.
60.	60.	60.	60.	60.	61.	61.	61.	61.	61.
61.	62.	62.	62.	62.	63.	63.	63.	63.	63.
63.	64.	64.	64.	64.	65.	66.	67.	69.	69.
70.	70.	70.	70.	70.	70.	70.	70.	70.	70.
70.	70.	70.	70.	70.	70.	70.	70.	70.	70.
70.	70.	70.	70.	70.	70.	70.	69.	69.	69.
69.	69.	69.	69.	69.	69.	68.	68.	68.	68.
68.	68.	68.	68.	68.	67.	67.	67.	67.	67.

67.	67.	67.	67.	67.	66.	66.	66.	66.	66.
66.	66.	66.	66.	65.	65.	65.	65.	65.	65.
65.	65.	65.	65.	65.	64.	64.	64.	64.	64.
64.	64.	64.	64.	64.	64.	64.	63.	63.	63.
63.	63.	63.	63.	63.	63.	63.	63.		

STAGE

571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.1	571.1	571.1
571.1	571.1	571.1	571.1	571.1	571.1	571.1	571.1	571.1	571.1
571.1	571.2	571.2	571.2	571.2	571.2	571.2	571.2	571.2	571.2
571.2	571.2	571.2	571.2	571.2	571.3	571.3	571.3	571.3	571.3
571.3	571.3	571.3	571.3	571.3	571.3	571.3	571.3	571.3	571.4
571.4	571.4	571.4	571.4	571.4	571.4	571.4	571.4	571.4	571.4
571.4	571.4	571.4	571.4	571.4	571.5	571.5	571.5	571.5	571.5
571.5	571.5	571.5	571.5	571.5	571.5	571.5	571.6	571.6	571.6
571.7	571.7	571.7	571.7	571.8	571.8	571.8	571.8	571.9	571.9
571.9	572.0	572.0	572.0	572.1	572.1	572.1	572.1	572.2	572.2
572.2	572.3	572.3	572.3	572.4	572.4	572.4	572.5	572.5	572.5
572.6	572.6	572.6	572.7	572.7	572.8	573.0	573.2	573.4	573.5
573.6	573.7	573.7	573.7	573.7	573.7	573.6	573.6	573.6	573.6
573.6	573.6	573.6	573.6	573.6	573.6	573.6	573.6	573.6	573.6
573.6	573.6	573.6	573.6	573.6	573.6	573.6	573.6	573.5	573.5
573.5	573.5	573.5	573.4	573.4	573.4	573.4	573.4	573.4	573.3
573.3	573.3	573.3	573.3	573.2	573.2	573.2	573.2	573.2	573.2
573.1	573.1	573.1	573.1	573.1	573.1	573.0	573.0	573.0	573.0
573.0	573.0	572.9	572.9	572.9	572.9	572.9	572.9	572.8	572.8
572.8	572.8	572.8	572.8	572.7	572.7	572.7	572.7	572.7	572.7
572.7	572.6	572.6	572.6	572.6	572.6	572.6	572.6	572.6	572.5
572.5	572.5	572.5	572.5	572.5	572.5	572.5	572.5		

PEAK OUTFLOW IS 49. AT TIME 16.17 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	49.	27.	10.	10.	2852.
CMS	1.	1.	0.	0.	81.
INCHES		3.64	5.34	5.34	5.34
MM		92.48	135.63	135.63	135.63
AC-FT		13.	20.	20.	20.
THOUS CU M		17.	24.	24.	24.

OVF

STATION000002 [0.24 PMF]

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

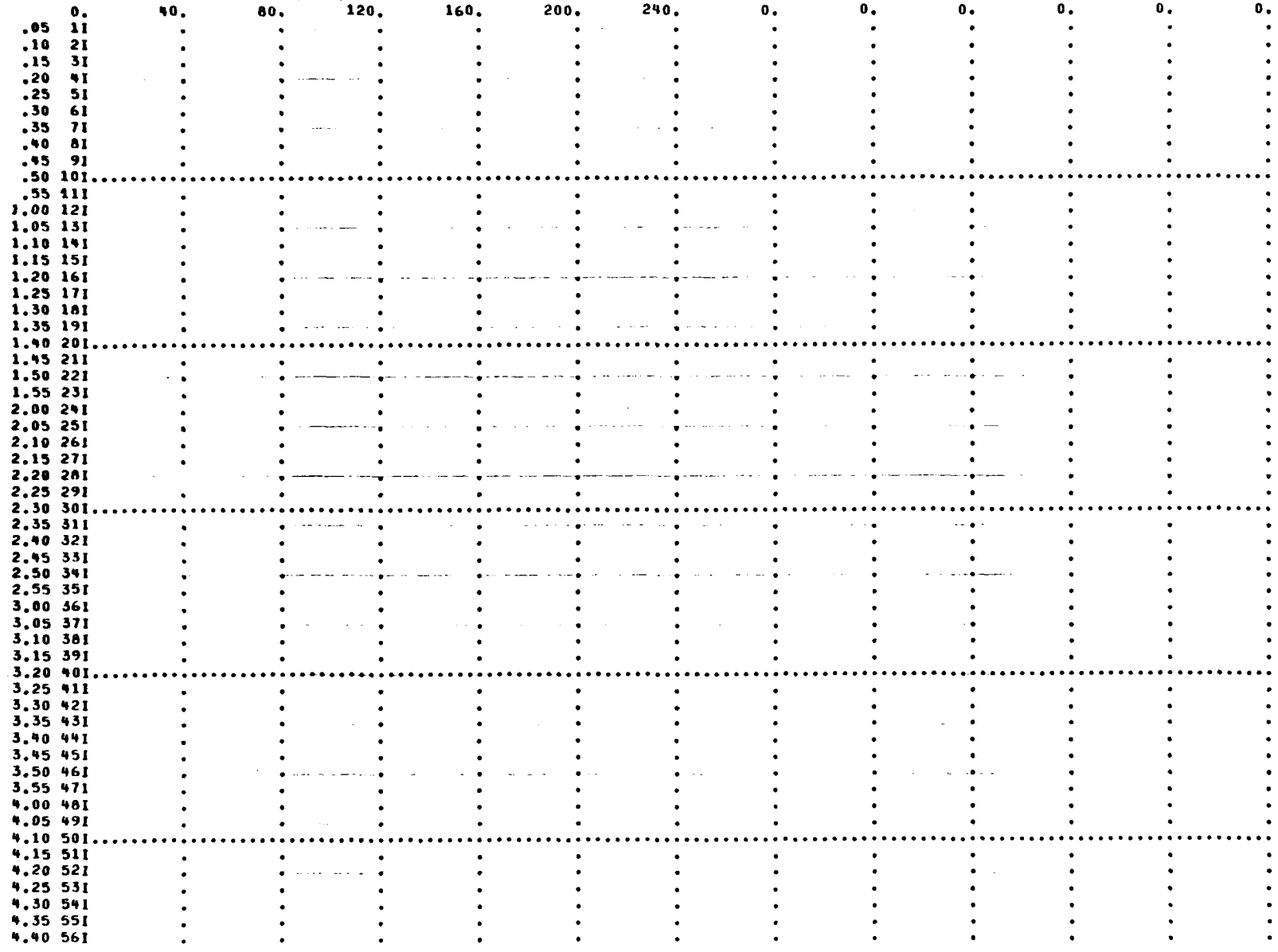


PLATE D-14

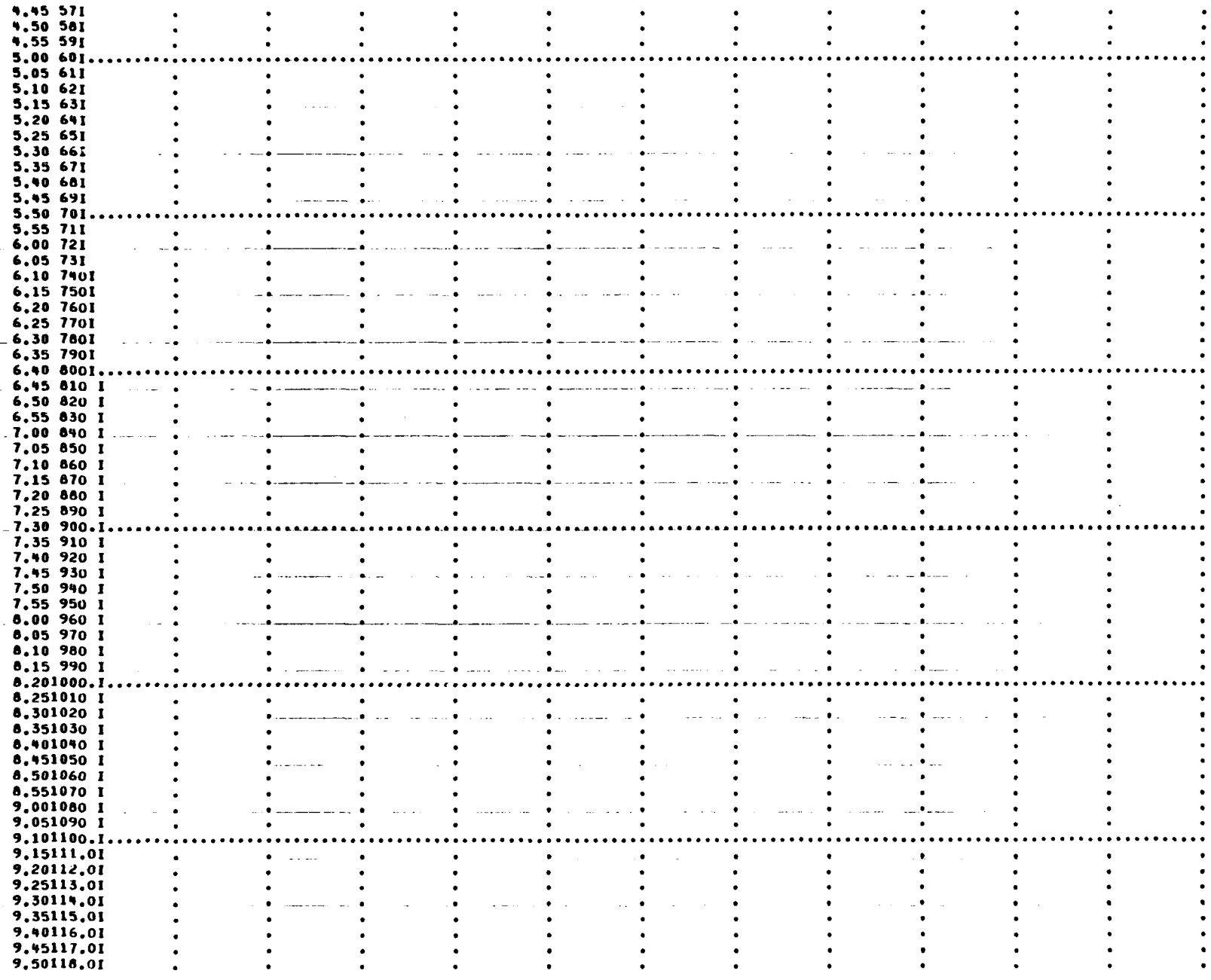
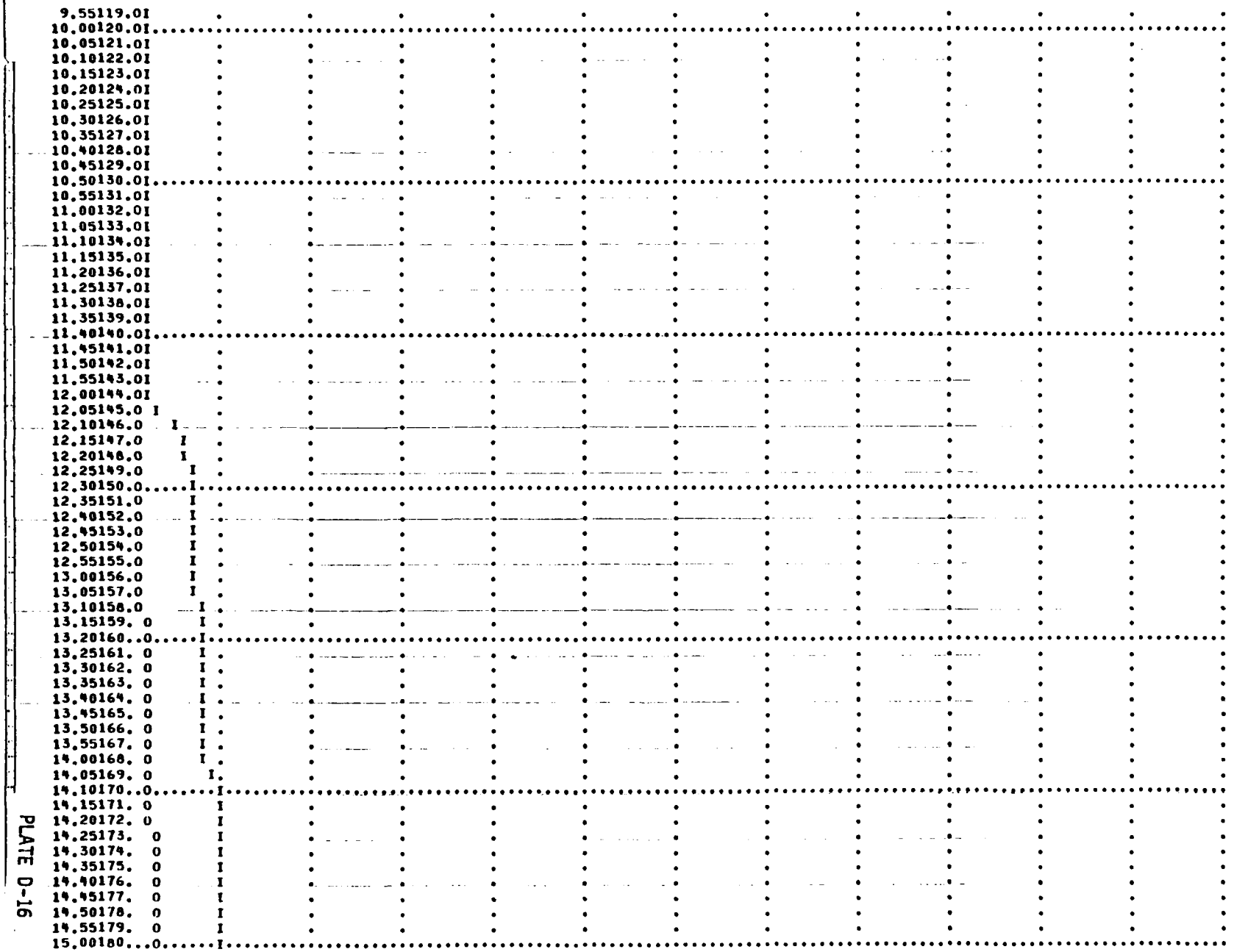

4.45 57I
4.50 58I
4.55 59I
5.00 60I
5.05 61I
5.10 62I
5.15 63I
5.20 64I
5.25 65I
5.30 66I
5.35 67I
5.40 68I
5.45 69I
5.50 70I
5.55 71I
6.00 72I
6.05 73I
6.10 740I
6.15 750I
6.20 760I
6.25 770I
6.30 780I
6.35 790I
6.40 800I
6.45 810 I
6.50 820 I
6.55 830 I
7.00 840 I
7.05 850 I
7.10 860 I
7.15 870 I
7.20 880 I
7.25 890 I
7.30 900.I
7.35 910 I
7.40 920 I
7.45 930 I
7.50 940 I
7.55 950 I
8.00 960 I
8.05 970 I
8.10 980 I
8.15 990 I
8.201000.I
8.251010 I
8.301020 I
8.351030 I
8.401040 I
8.451050 I
8.501060 I
8.551070 I
9.001080 I
9.051090 I
9.101100.I
9.15111.0I
9.20112.0I
9.25113.0I
9.30114.0I
9.35115.0I
9.40116.0I
9.45117.0I
9.50118.0I

PLATE D-15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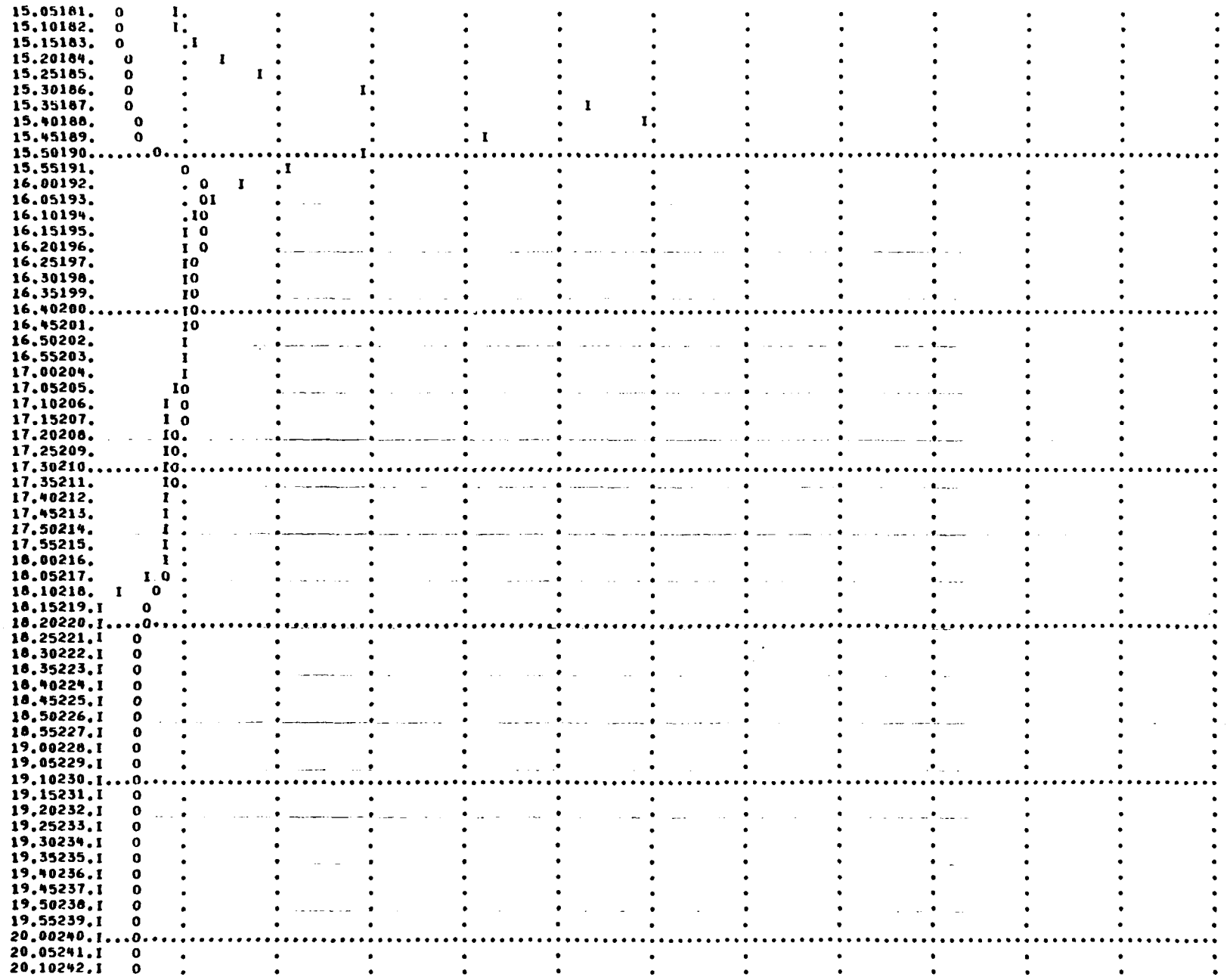
10.05121.0I
10.10122.0I
10.15123.0I
10.20124.0I
10.25125.0I
10.30126.0I
10.35127.0I
10.40128.0I
10.45129.0I
10.50130.0I
10.55131.0I
11.00132.0I
11.05133.0I
11.10134.0I
11.15135.0I
11.20136.0I
11.25137.0I
11.30138.0I
11.35139.0I
11.40140.0I
11.45141.0I
11.50142.0I
11.55143.0I
12.00144.0I
12.05145.0 I
12.10146.0 I
12.15147.0 I
12.20148.0 I
12.25149.0 I
12.30150.0 I
12.35151.0 I
12.40152.0 I
12.45153.0 I
12.50154.0 I
12.55155.0 I
13.00156.0 I
13.05157.0 I
13.10158.0 I
13.15159. 0 I
13.20160..0 I
13.25161. 0 I
13.30162. 0 I
13.35163. 0 I
13.40164. 0 I
13.45165. 0 I
13.50166. 0 I
13.55167. 0 I
14.00168. 0 I
14.05169. 0 I
14.10170..0 I
14.15171. 0 I
14.20172. 0 I
14.25173. 0 I
14.30174. 0 I
14.35175. 0 I
14.40176. 0 I
14.45177. 0 I
14.50178. 0 I
14.55179. 0 I
15.00180...0 I

PLATE D-16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15.15183.
15.20184.
15.25185.
15.30186.
15.35187.
15.40188.
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15.50190.
15.55191.
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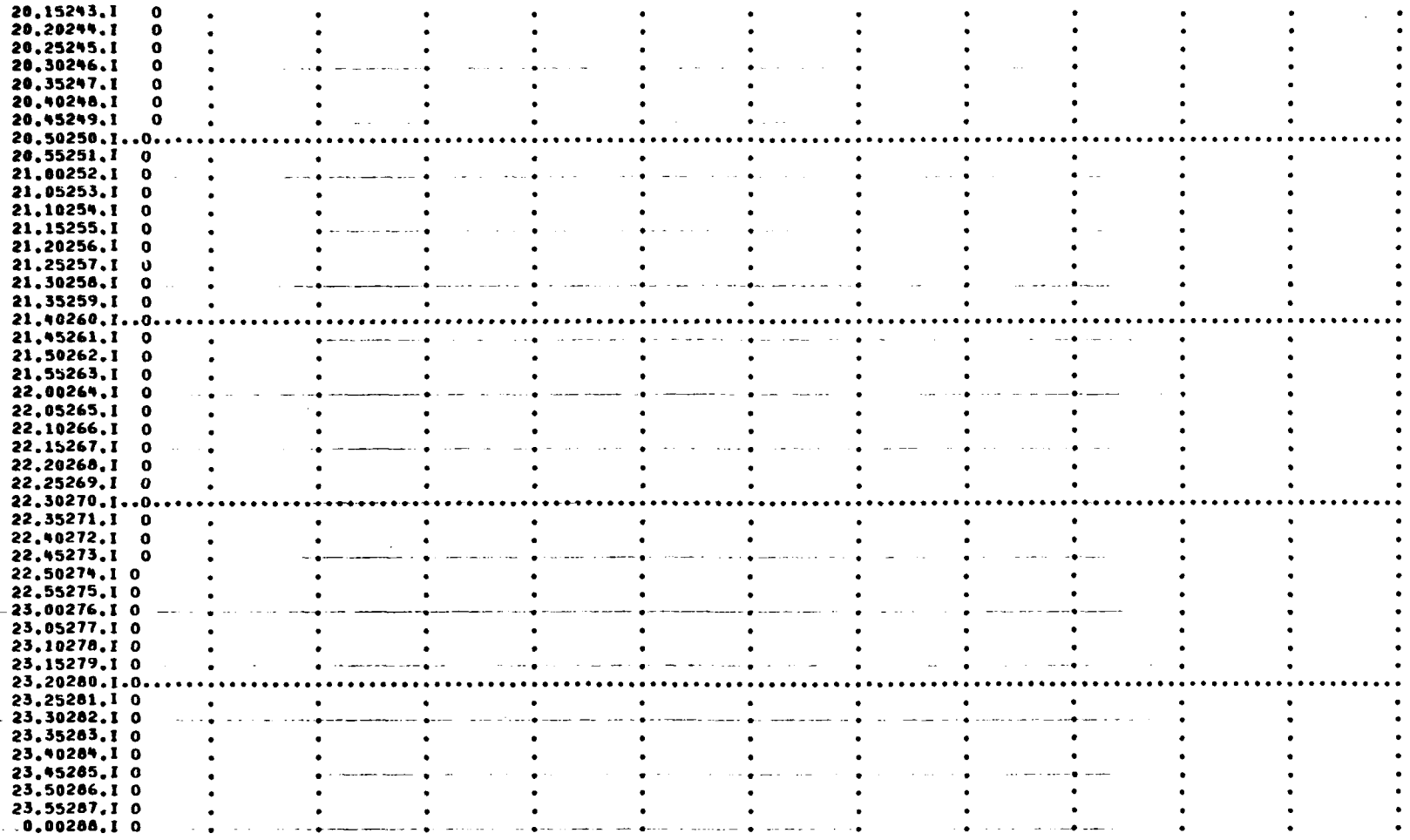
16.05193.
16.10194.
16.15195.
16.20196.
16.25197.
16.30198.
16.35199.
16.40200.
16.45201.
16.50202.
16.55203.
17.00204.
17.05205.
17.10206.
17.15207.
17.20208.
17.25209.
17.30210.
17.35211.
17.40212.
17.45213.
17.50214.
17.55215.
18.00216.
18.05217.
18.10218.
18.15219.
18.20220.
18.25221.
18.30222.
18.35223.
18.40224.
18.45225.
18.50226.
18.55227.
19.00228.
19.05229.
19.10230.
19.15231.
19.20232.
19.25233.
19.30234.
19.35235.
19.40236.
19.45237.
19.50238.
19.55239.
20.00240.
20.05241.
20.10242.

PLATE D-17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20.35247.I 0
20.40248.I 0
20.45249.I 0
20.50250.I 0
20.55251.I 0
21.00252.I 0
21.05253.I 0
21.10254.I 0
21.15255.I 0
21.20256.I 0
21.25257.I 0
21.30258.I 0
21.35259.I 0
21.40260.I 0
21.45261.I 0
21.50262.I 0
21.55263.I 0
22.00264.I 0
22.05265.I 0
22.10266.I 0
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22.40272.I 0
22.45273.I 0
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23.25281.I 0
23.30282.I 0
23.35283.I 0
23.40284.I 0
23.45285.I 0
23.50286.I 0
23.55287.I 0
0.00288.I 0

PLATE D-18

OVN

STATION 000002, PLAN 1, RATIO 7 0.5 PMF

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	2.	2.	2.	2.	2.
2.	2.	2.	2.	3.	3.	3.	3.	3.	3.
3.	3.	3.	3.	4.	4.	4.	4.	4.	4.
4.	4.	4.	4.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	6.	6.	6.	6.	6.	6.
6.	6.	6.	6.	6.	7.	7.	7.	7.	7.
7.	7.	7.	7.	8.	8.	8.	9.	10.	10.
11.	11.	12.	12.	13.	14.	14.	15.	15.	16.
17.	17.	18.	18.	18.	19.	19.	19.	19.	20.
20.	24.	35.	44.	51.	58.	64.	68.	72.	75.
77.	77.	79.	85.	99.	132.	247.	413.	419.	321.
244.	189.	152.	131.	116.	105.	99.	94.	91.	88.
86.	85.	84.	83.	82.	80.	77.	74.	72.	70.
69.	68.	67.	66.	66.	65.	63.	57.	50.	43.
37.	32.	27.	23.	20.	20.	20.	20.	20.	20.
20.	20.	20.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
18.	18.	18.	18.	18.	18.	18.	18.	18.	18.
18.	18.	17.	17.	17.	17.	17.	17.	16.	16.
16.	16.	16.	16.	16.	16.	15.	15.	15.	15.
15.	15.	15.	15.	14.	14.	14.	14.		

STORAGE

54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	56.	56.	56.	56.	56.	56.
56.	56.	56.	56.	56.	56.	57.	57.	57.	57.
57.	57.	57.	57.	57.	57.	57.	57.	58.	58.
58.	58.	58.	58.	58.	58.	58.	58.	58.	58.
59.	59.	59.	59.	59.	59.	59.	59.	59.	59.
59.	59.	59.	60.	60.	60.	60.	60.	60.	60.
60.	60.	60.	60.	60.	61.	61.	61.	61.	62.
62.	62.	63.	63.	63.	64.	64.	64.	65.	65.
65.	66.	66.	66.	67.	67.	67.	68.	68.	68.
69.	69.	70.	70.	70.	70.	71.	71.	71.	71.
71.	71.	71.	71.	71.	72.	73.	74.	74.	73.
73.	73.	72.	72.	72.	72.	71.	71.	71.	71.
71.	71.	71.	71.	71.	71.	71.	71.	71.	71.
71.	71.	71.	71.	71.	71.	71.	70.	70.	70.
70.	70.	69.	69.	69.	69.	69.	69.	69.	69.
69.	69.	68.	68.	68.	68.	68.	68.	68.	68.

PLATE D-19

68.	68.	68.	67.	67.	67.	67.	67.	67.	67.
67.	67.	67.	66.	66.	66.	66.	66.	66.	66.
66.	66.	66.	66.	66.	65.	65.	65.	65.	65.
65.	65.	65.	65.	65.	65.	65.	65.	64.	64.
64.	64.	64.	64.	64.	64.	64.	64.		

STAGE

571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.1	571.1
571.1	571.1	571.1	571.1	571.1	571.1	571.1	571.1	571.1	571.1
571.2	571.2	571.2	571.2	571.2	571.2	571.2	571.3	571.3	571.3
571.3	571.3	571.3	571.3	571.4	571.4	571.4	571.4	571.4	571.4
571.5	571.5	571.5	571.5	571.5	571.5	571.5	571.6	571.6	571.6
571.6	571.6	571.6	571.6	571.7	571.7	571.7	571.7	571.7	571.7
571.7	571.8	571.8	571.8	571.8	571.8	571.8	571.8	571.8	571.9
571.9	571.9	571.9	571.9	571.9	571.9	571.9	572.0	572.0	572.0
572.0	572.0	572.0	572.0	572.1	572.1	572.1	572.2	572.2	572.3
572.3	572.4	572.4	572.5	572.5	572.6	572.6	572.7	572.8	572.8
572.9	572.9	573.0	573.0	573.1	573.2	573.2	573.3	573.3	573.4
573.5	573.5	573.6	573.6	573.7	573.7	573.7	573.8	573.8	573.8
573.8	573.8	573.8	573.8	573.9	574.0	574.1	574.3	574.3	574.2
574.1	574.0	574.0	573.9	573.9	573.9	573.9	573.9	573.8	573.8
573.8	573.8	573.8	573.8	573.8	573.8	573.8	573.8	573.8	573.8
573.8	573.8	573.8	573.8	573.8	573.7	573.7	573.7	573.7	573.6
573.6	573.6	573.5	573.5	573.5	573.5	573.5	573.5	573.4	573.4
573.4	573.4	573.4	573.4	573.4	573.3	573.3	573.3	573.3	573.3
573.3	573.2	573.2	573.2	573.2	573.2	573.2	573.2	573.1	573.1
573.1	573.1	573.1	573.1	573.1	573.0	573.0	573.0	573.0	573.0
573.0	573.0	572.9	572.9	572.9	572.9	572.9	572.9	572.9	572.8
572.8	572.8	572.8	572.8	572.8	572.8	572.8	572.8	572.7	572.7
572.7	572.7	572.7	572.7	572.7	572.7	572.7	572.6		

PEAK OUTFLOW IS 419. AT TIME 15.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	419.	78.	25.	25.	7067.
CMS	12.	2.	1.	1.	200.
INCHES		10.57	13.23	13.23	13.23
MM		268.53	336.13	336.13	336.13
AC-FT		39.	49.	49.	49.
THOUS CU M		48.	60.	60.	60.

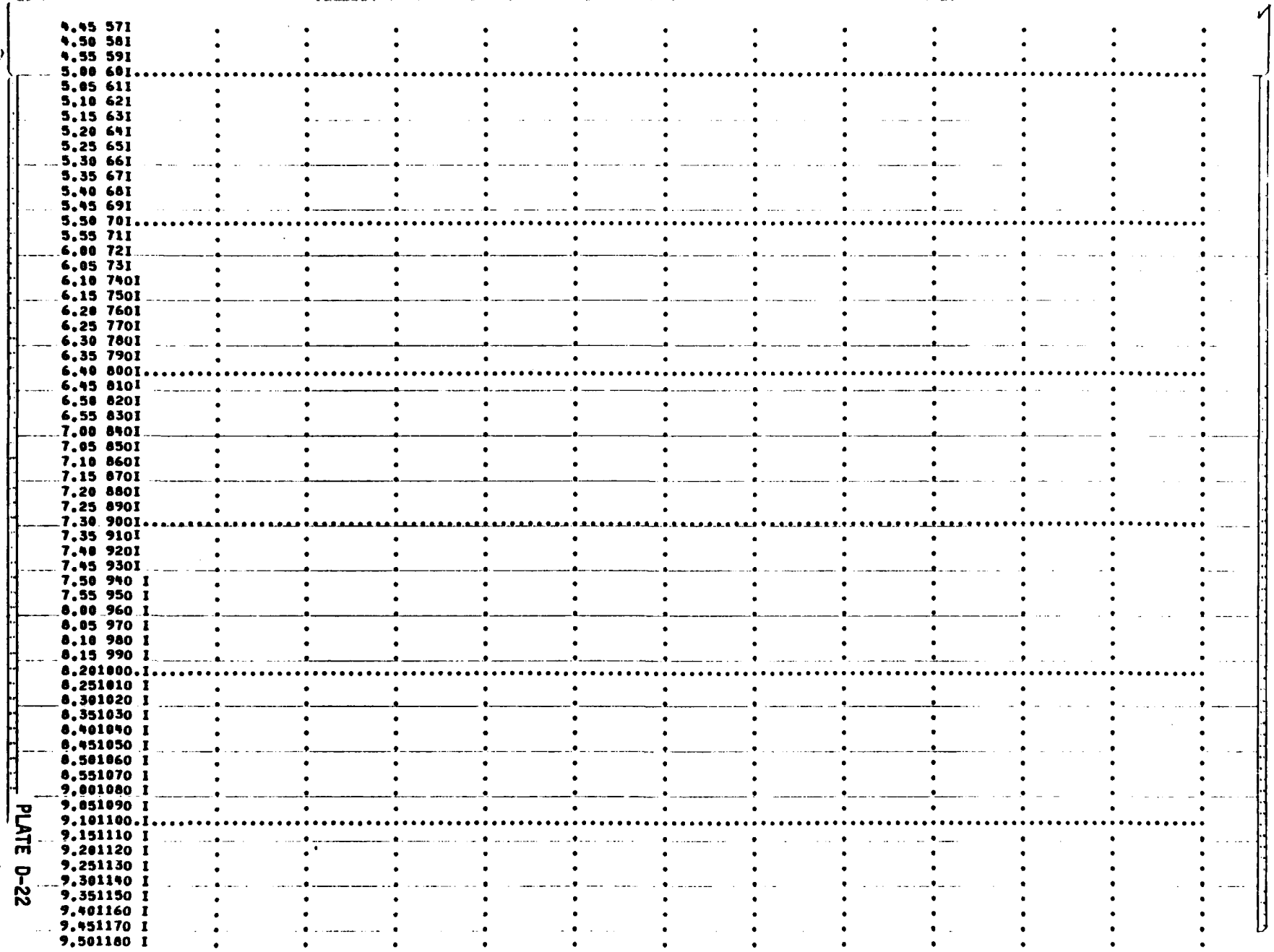
OVF

STATION000002 0.5 PMF

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

	0.	100.	200.	300.	400.	500.	0.	0.	0.	0.	0.	0.	0.
.05	1I												
.10	2I												
.15	3I												
.20	4I												
.25	5I												
.30	6I												
.35	7I												
.40	8I												
.45	9I												
.50	10I												
.55	11I												
1.00	12I												
1.05	13I												
1.10	14I												
1.15	15I												
1.20	16I												
1.25	17I												
1.30	18I												
1.35	19I												
1.40	20I												
1.45	21I												
1.50	22I												
1.55	23I												
2.00	24I												
2.05	25I												
2.10	26I												
2.15	27I												
2.20	28I												
2.25	29I												
2.30	30I												
2.35	31I												
2.40	32I												
2.45	33I												
2.50	34I												
2.55	35I												
3.00	36I												
3.05	37I												
3.10	38I												
3.15	39I												
3.20	40I												
3.25	41I												
3.30	42I												
3.35	43I												
3.40	44I												
3.45	45I												
3.50	46I												
3.55	47I												
4.00	48I												
4.05	49I												
4.10	50I												
4.15	51I												
4.20	52I												
4.25	53I												
4.30	54I												
4.35	55I												
4.40	56I												

PLATE D-21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4.55 591
5.00 601
5.05 611
5.10 621
5.15 631
5.20 641
5.25 651
5.30 661
5.35 671
5.40 681
5.45 691
5.50 701
5.55 711
6.00 721
6.05 731
6.10 740I
6.15 750I
6.20 760I
6.25 770I
6.30 780I
6.35 790I
6.40 800I
6.45 810I
6.50 820I
6.55 830I
7.00 840I
7.05 850I
7.10 860I
7.15 870I
7.20 880I
7.25 890I
7.30 900I
7.35 910I
7.40 920I
7.45 930I
7.50 940 I
7.55 950 I
8.00 960 I
8.05 970 I
8.10 980 I
8.15 990 I
8.201000.I
8.251010 I
8.301020 I
8.351030 I
8.401040 I
8.451050 I
8.501060 I
8.551070 I
9.001080 I
9.051090 I
9.101100.I
9.151110 I
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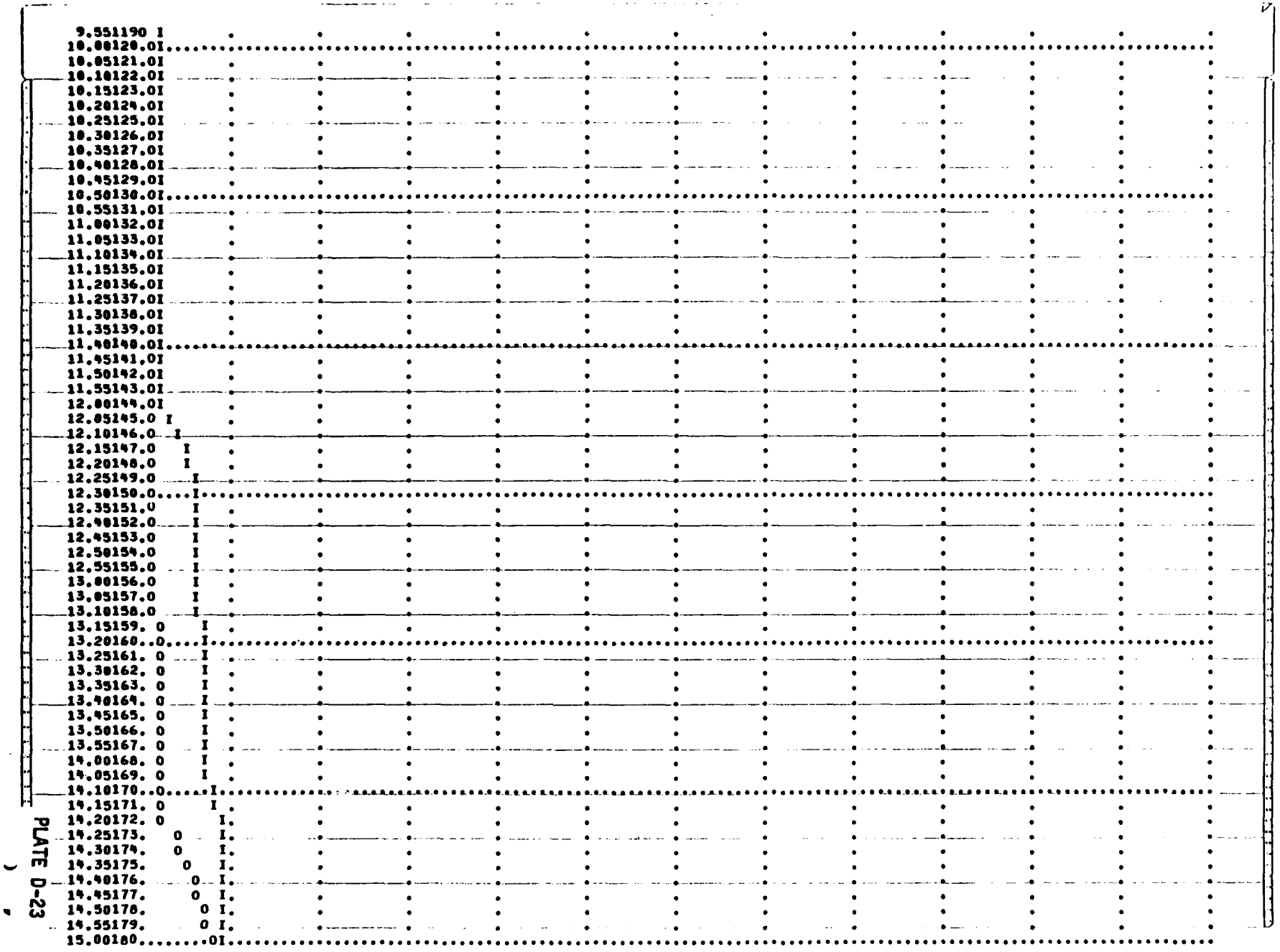
9.301140 I
9.351150 I
9.401160 I
9.451170 I
9.501180 I

PLATE D-22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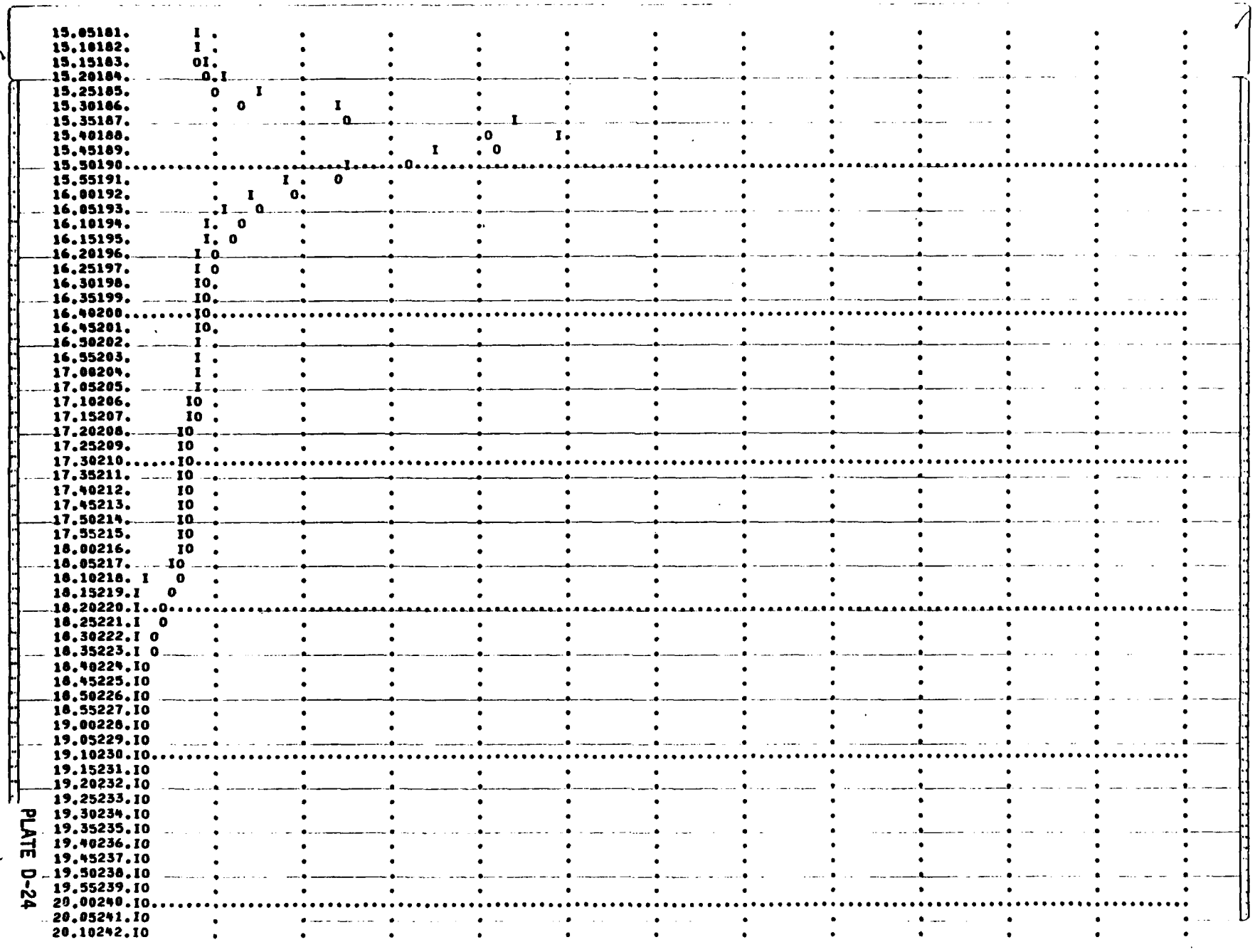
10.05121.0I
10.10122.0I
10.15123.0I
10.20124.0I
10.25125.0I
10.30126.0I
10.35127.0I
10.40128.0I
10.45129.0I
10.50130.0I
10.55131.0I
11.00132.0I
11.05133.0I
11.10134.0I
11.15135.0I
11.20136.0I
11.25137.0I
11.30138.0I
11.35139.0I
11.40140.0I
11.45141.0I
11.50142.0I
11.55143.0I
12.00144.0I
12.05145.0 I
12.10146.0 I
12.15147.0 I
12.20148.0 I
12.25149.0 I
12.30150.0 I
12.35151.0 I
12.40152.0 I
12.45153.0 I
12.50154.0 I
12.55155.0 I
13.00156.0 I
13.05157.0 I
13.10158.0 I
13.15159. 0 I
13.20160..0 I
13.25161. 0 I
13.30162. 0 I
13.35163. 0 I
13.40164. 0 I
13.45165. 0 I
13.50166. 0 I
13.55167. 0 I
14.00168. 0 I
14.05169. 0 I
14.10170..0 I
14.15171. 0 I
14.20172. 0 I.
14.25173. 0 I.
14.30174. 0 I.
14.35175. 0 I.
14.40176. 0 I.
14.45177. 0 I.
14.50178. 0 I.
14.55179. 0 I.
15.00180.....0I

PLATE D-23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15.20184. O I
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15.30186. O I
15.35187. O I
15.40188. O I
15.45189. I O
15.50190. I O
15.55191. I O
16.00192. I O
16.05193. I O
16.10194. I O
16.15195. I O
16.20196. I O
16.25197. I O
16.30198. IO
16.35199. IO
16.40200. IO
16.45201. IO
16.50202. I
16.55203. I
17.00204. I
17.05205. I
17.10206. IO
17.15207. IO
17.20208. IO
17.25209. IO
17.30210. IO
17.35211. IO
17.40212. IO
17.45213. IO
17.50214. IO
17.55215. IO
18.00216. IO
18.05217. IO
18.10218. I O
18.15219. I O
18.20220. I O
18.25221. I O
18.30222. I O
18.35223. I O
18.40224. IO
18.45225. IO
18.50226. IO
18.55227. IO
19.00228. IO
19.05229. IO
19.10230. IO
19.15231. IO
19.20232. IO
19.25233. IO
19.30234. IO
19.35235. IO
19.40236. IO
19.45237. IO
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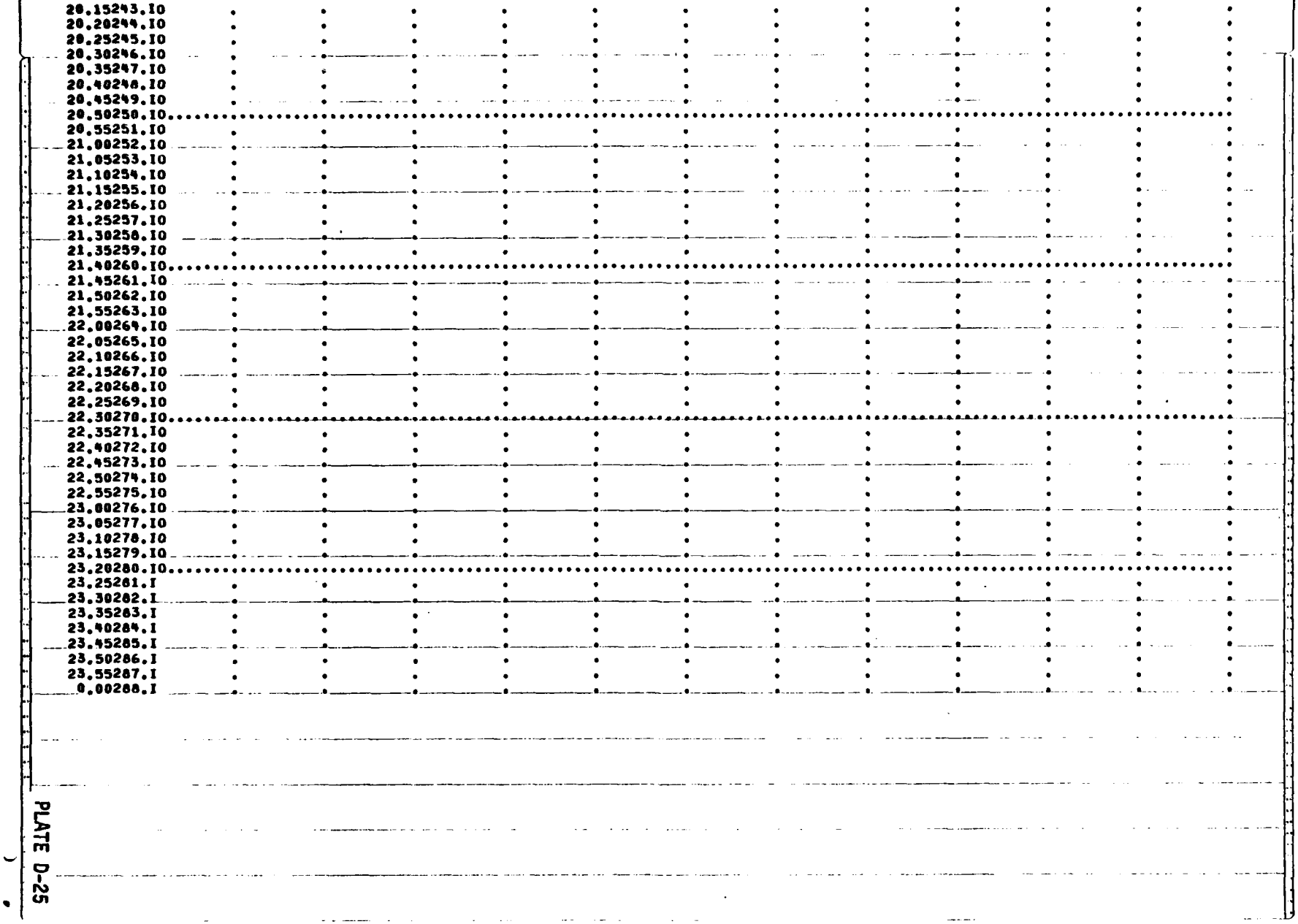
PLATE D-24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0.00288.I

PLATE D-25

OVN

STATION 000002, PLAN 1, RATIO 8 [PMF]

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	2.	2.	2.
2.	2.	3.	3.	3.	3.	3.	4.	4.	4.
4.	4.	5.	5.	5.	5.	5.	6.	6.	6.
6.	6.	7.	7.	7.	7.	8.	8.	8.	9.
9.	9.	10.	10.	10.	10.	11.	11.	11.	12.
12.	12.	12.	13.	13.	13.	13.	14.	14.	14.
14.	15.	15.	15.	15.	16.	16.	16.	16.	17.
17.	17.	17.	17.	18.	18.	18.	19.	19.	20.
24.	39.	52.	64.	76.	86.	95.	104.	113.	120.
125.	128.	131.	133.	134.	135.	136.	136.	138.	144.
151.	159.	165.	168.	170.	171.	172.	172.	172.	172.
168.	161.	165.	189.	234.	343.	641.	932.	839.	599.
440.	335.	270.	225.	196.	181.	172.	167.	164.	163.
162.	162.	162.	162.	159.	153.	146.	140.	136.	133.
131.	130.	129.	128.	128.	128.	122.	105.	84.	67.
56.	48.	42.	36.	32.	28.	25.	23.	21.	20.
20.	20.	20.	20.	20.	20.	20.	20.	20.	20.
20.	20.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	19.	19.
19.	19.	19.	19.	19.	19.	19.	19.	18.	18.
18.	18.	18.	18.	18.	18.	18.	18.	18.	18.
18.	18.	18.	18.	18.	18.	18.	18.		

STORAGE

54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	54.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	56.	56.	56.
56.	56.	56.	57.	57.	57.	57.	57.	57.	58.
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59.	60.	60.	60.	60.	60.	60.	61.	61.	61.
61.	61.	61.	62.	62.	62.	62.	62.	62.	63.
63.	63.	63.	63.	63.	63.	64.	64.	64.	64.
64.	64.	64.	65.	65.	65.	65.	65.	65.	65.
65.	66.	66.	66.	66.	66.	67.	67.	68.	69.
69.	70.	70.	71.	71.	71.	71.	72.	72.	72.
72.	72.	72.	72.	72.	72.	72.	72.	72.	72.
72.	72.	72.	72.	72.	72.	72.	72.	72.	72.
72.	72.	72.	73.	73.	74.	75.	76.	76.	75.
74.	74.	73.	73.	73.	73.	72.	72.	72.	72.
72.	72.	72.	72.	72.	72.	72.	72.	72.	72.
72.	72.	72.	72.	72.	72.	72.	72.	71.	71.
70.	70.	70.	70.	70.	69.	69.	69.	69.	69.
69.	69.	69.	69.	69.	69.	69.	69.	69.	69.

PLATE D-26

68.	68.	68.	68.	68.	68.	68.	68.	68.	68.
68.	68.	68.	68.	68.	68.	68.	67.	67.	67.
67.	67.	67.	67.	67.	67.	67.	67.	67.	67.
67.	67.	67.	67.	66.	66.	66.	66.	66.	66.
66.	66.	66.	66.	66.	66.	66.	66.		

STAGE

571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0	571.0
571.0	571.0	571.0	571.1	571.1	571.1	571.1	571.1	571.1	571.1
571.1	571.1	571.1	571.1	571.1	571.1	571.1	571.1	571.1	571.1
571.1	571.1	571.1	571.1	571.1	571.2	571.2	571.2	571.2	571.3
571.3	571.3	571.4	571.4	571.4	571.4	571.5	571.5	571.5	571.6
571.6	571.6	571.7	571.7	571.7	571.7	571.8	571.8	571.8	571.9
571.9	571.9	572.0	572.0	572.0	572.0	572.1	572.1	572.1	572.2
572.2	572.2	572.2	572.3	572.3	572.3	572.3	572.4	572.4	572.4
572.4	572.5	572.5	572.5	572.5	572.6	572.6	572.6	572.6	572.7
572.7	572.7	572.7	572.7	572.8	572.8	572.8	572.8	572.8	572.9
572.9	572.9	572.9	572.9	573.0	573.0	573.1	573.2	573.3	573.4
573.5	573.6	573.7	573.7	573.8	573.8	573.9	573.9	573.9	573.9
573.9	573.9	573.9	574.0	574.0	574.0	574.0	574.0	574.0	574.0
574.0	574.0	574.0	574.0	574.0	574.0	574.0	574.0	574.0	574.0
574.0	574.0	574.0	574.0	574.1	574.2	574.4	574.6	574.5	574.4
574.3	574.2	574.1	574.1	574.1	574.0	574.0	574.0	574.0	574.0
574.0	574.0	574.0	574.0	574.0	574.0	574.0	574.0	574.0	574.0
573.9	573.9	573.9	573.9	573.9	573.9	573.9	573.9	573.8	573.8
573.7	573.7	573.6	573.6	573.6	573.5	573.5	573.5	573.5	573.5
573.5	573.5	573.5	573.5	573.4	573.4	573.4	573.4	573.4	573.4
573.4	573.4	573.4	573.4	573.3	573.3	573.3	573.3	573.3	573.3
573.3	573.3	573.3	573.3	573.3	573.2	573.2	573.2	573.2	573.2
573.2	573.2	573.2	573.2	573.2	573.2	573.1	573.1	573.1	573.1
573.1	573.1	573.1	573.1	573.1	573.1	573.1	573.0	573.0	573.0
573.0	573.0	573.0	573.0	573.0	573.0	573.0	573.0		

PEAK OUTFLOW IS 932. AT TIME 15.67 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	932.	183.	53.	53.	15204.
CMS	26.	5.	1.	1.	431.
INCHES		24.64	28.47	28.47	28.47
MM		625.81	723.08	723.08	723.08
AC-FT		91.	105.	105.	105.
THOUS CU M		112.	129.	129.	129.

OVF

STATION000002 PMF

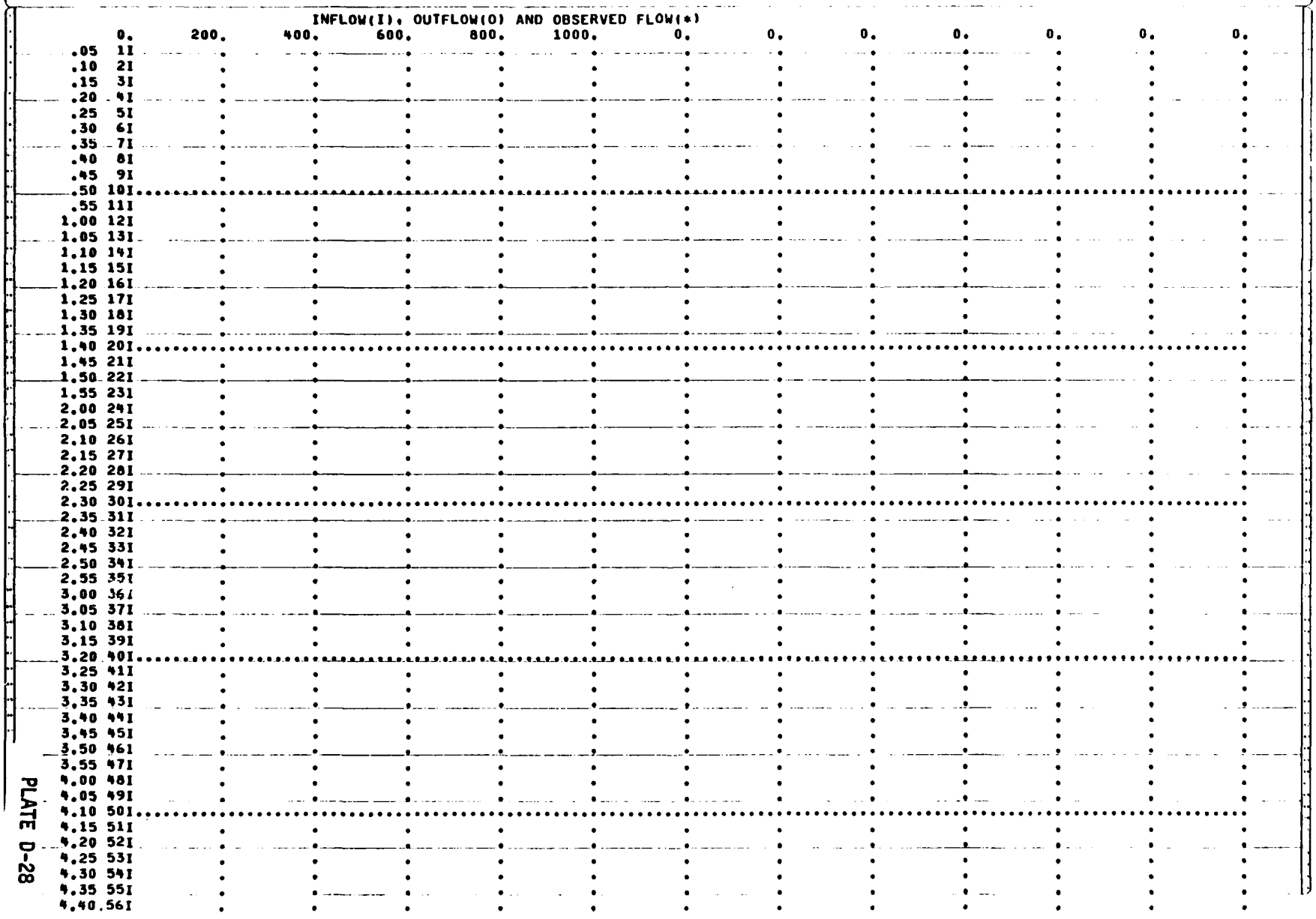
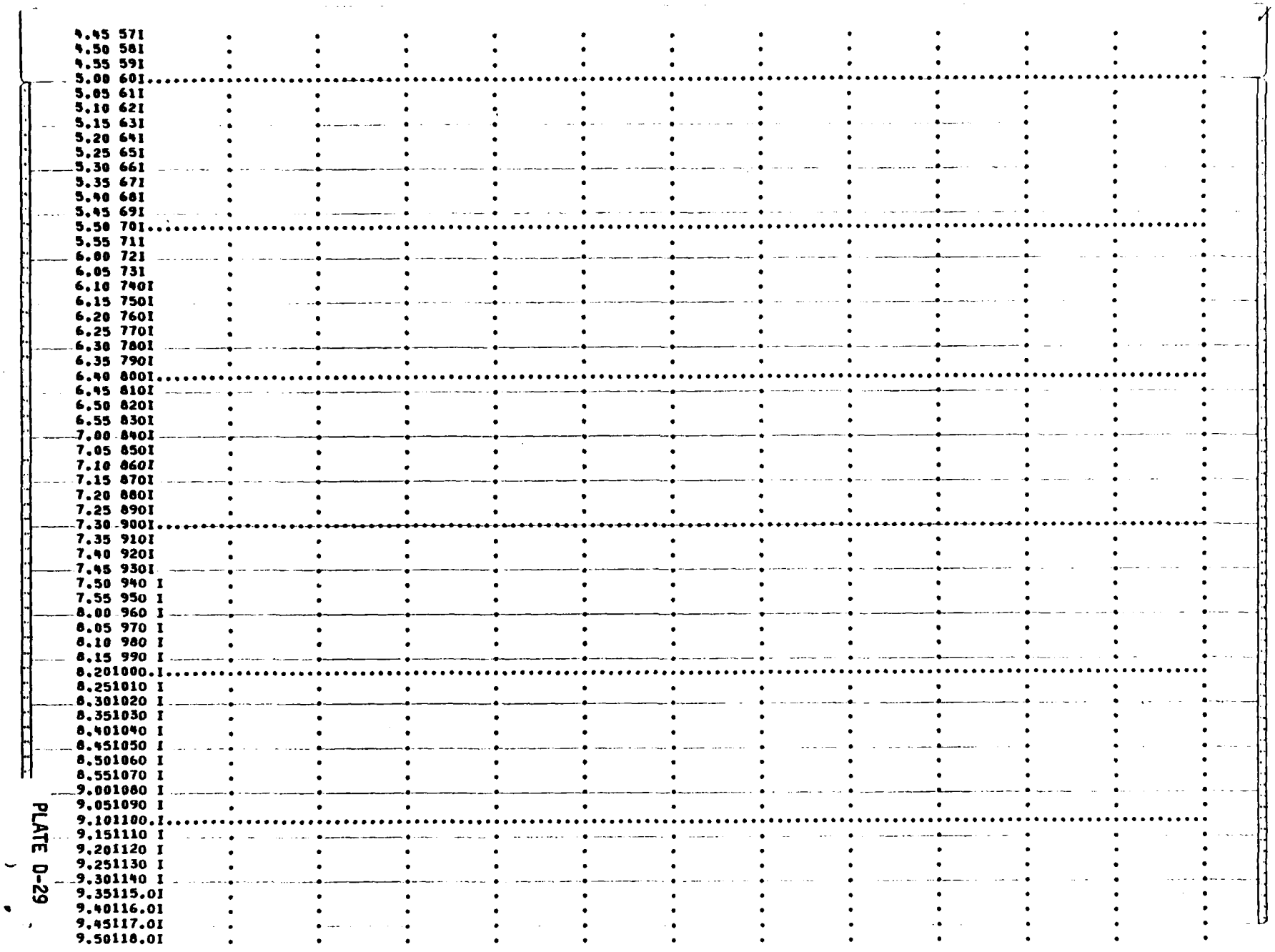


PLATE D-28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5.05 611
5.10 621
5.15 631
5.20 641
5.25 651
5.30 661
5.35 671
5.40 681
5.45 691
5.50 701
5.55 711
6.00 721
6.05 731
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6.15 750I
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6.25 770I
6.30 780I
6.35 790I
6.40 800I
6.45 810I
6.50 820I
6.55 830I
7.00 840I
7.05 850I
7.10 860I
7.15 870I
7.20 880I
7.25 890I
7.30 900I
7.35 910I
7.40 920I
7.45 930I
7.50 940 I
7.55 950 I
8.00 960 I
8.05 970 I
8.10 980 I
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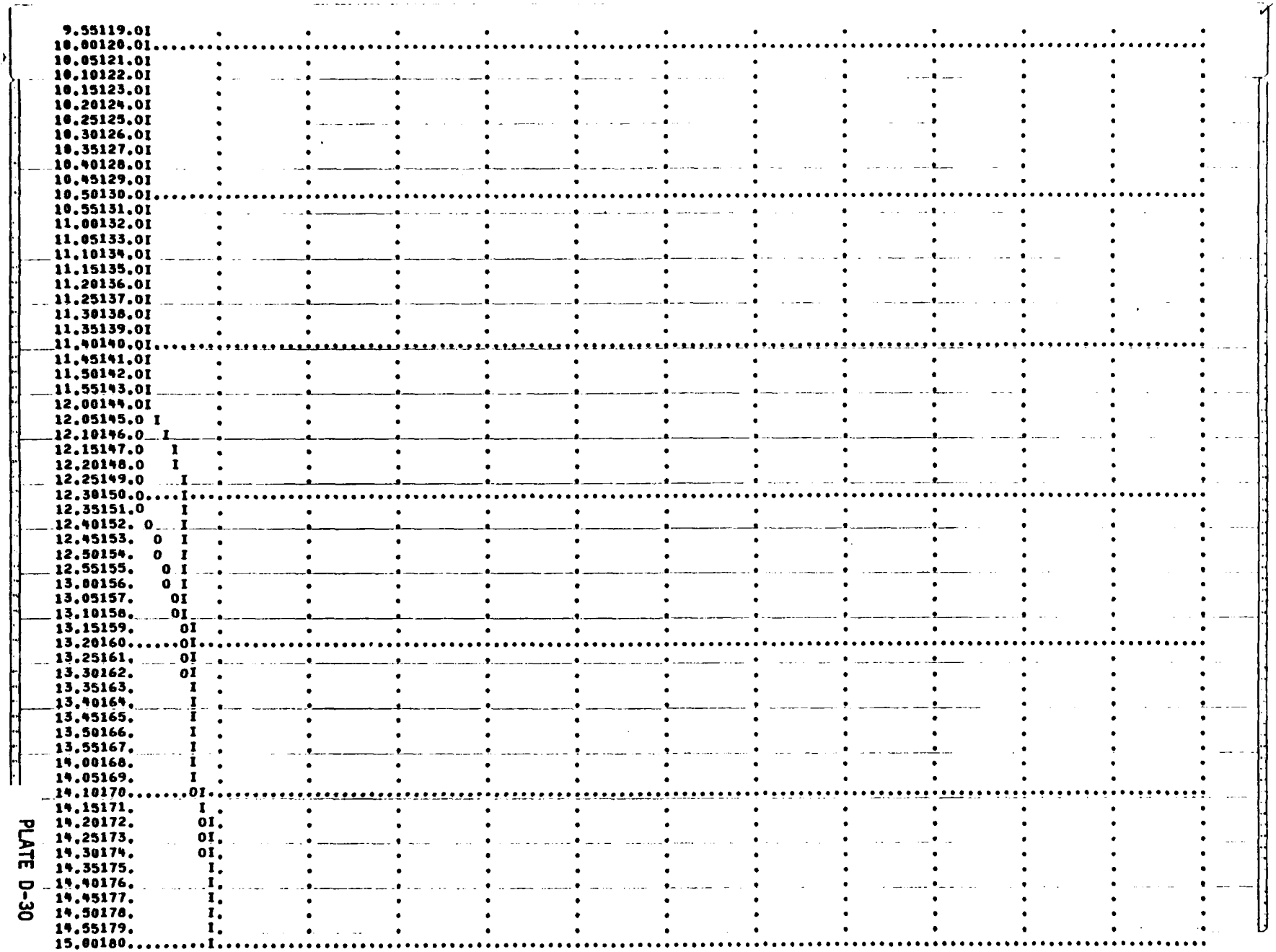
PLATE D-29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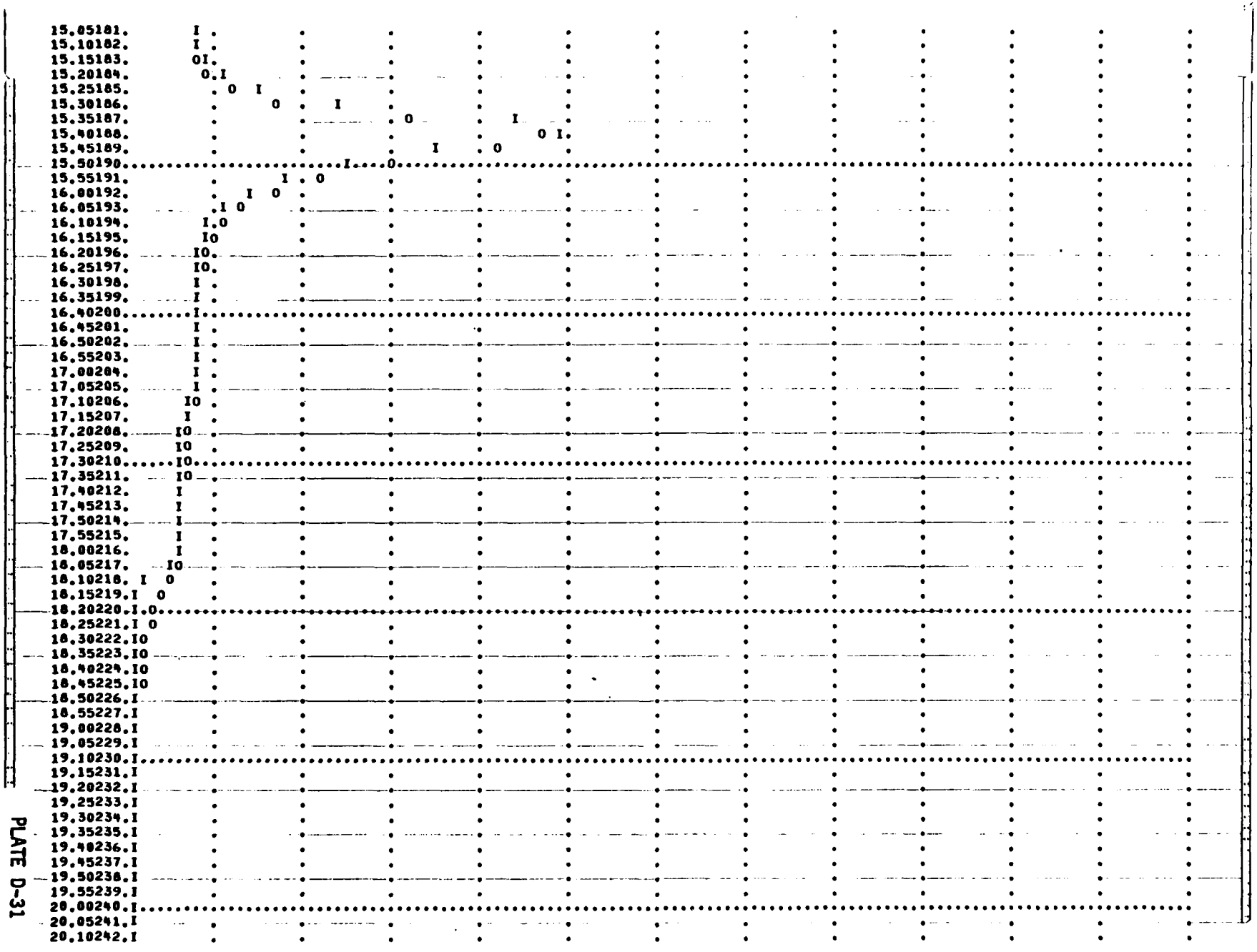
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16.20196.
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16.30198.
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PLATE D-31

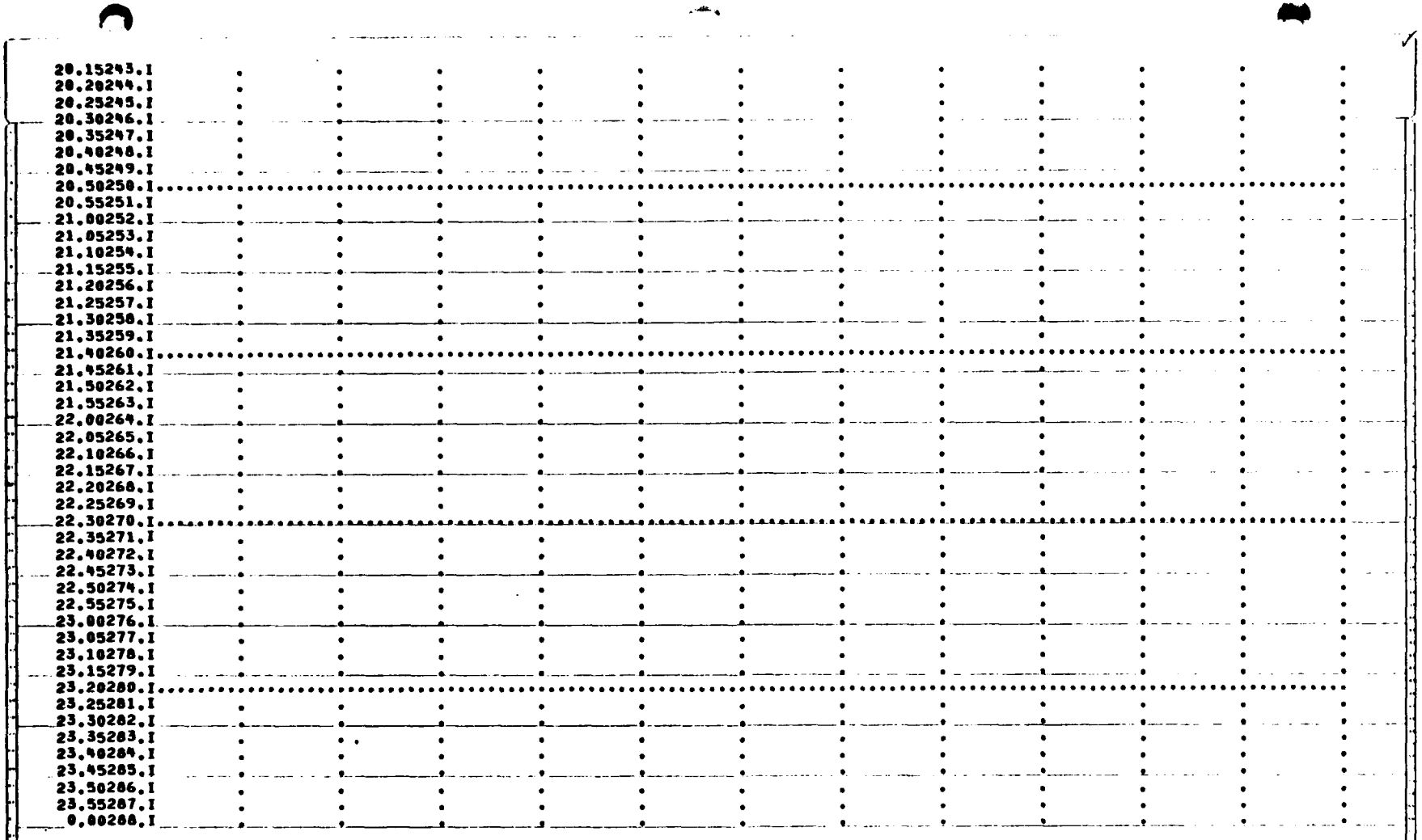
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PLATE D-32

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS							
				RATIO 1 .20	RATIO 2 .21	RATIO 3 .22	RATIO 4 .23	RATIO 5 .24	RATIO 6 .25	RATIO 7 .50	RATIO 8 1.00
HYDROGRAPH AT	000001	.07	1	196.	206.	216.	226.	235.	245.	491.	981.
	(	.18)	(	5.56)(	5.83)(	6.11)(	6.39)(	6.67)(	6.95)(	13.89)(	27.79)(
ROUTED TO	000002	.07	1	24.	30.	34.	39.	49.	59.	419.	932.
	(	.18)	(	.68)(	.85)(	.97)(	1.11)(	1.38)(	1.68)(	11.87)(	26.40)(

PLATE D-33

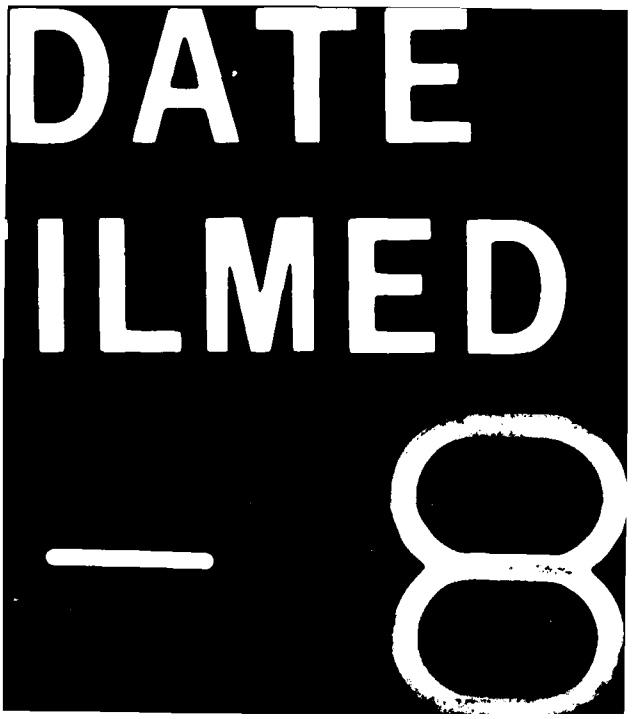
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	571.00	571.00	573.70
STORAGE	54.	54.	70.
OUTFLOW	0.	0.	55.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	573.52	0.00	69.	24.	0.00	18.00	0.00
.21	573.56	0.00	70.	30.	0.00	17.17	0.00
.22	573.58	0.00	70.	34.	0.00	17.08	0.00
.23	573.61	0.00	70.	39.	0.00	16.25	0.00
.24	573.66	0.00	70.	49.	0.00	16.17	0.00
.25	573.72	.02	71.	59.	.33	16.08	0.00
.50	574.26	.56	74.	419.	3.58	15.75	0.00
1.00	574.55	.85	76.	932.	5.67	15.67	0.00

PLATE D-34


DATE
ILMED
8